# The Engineer

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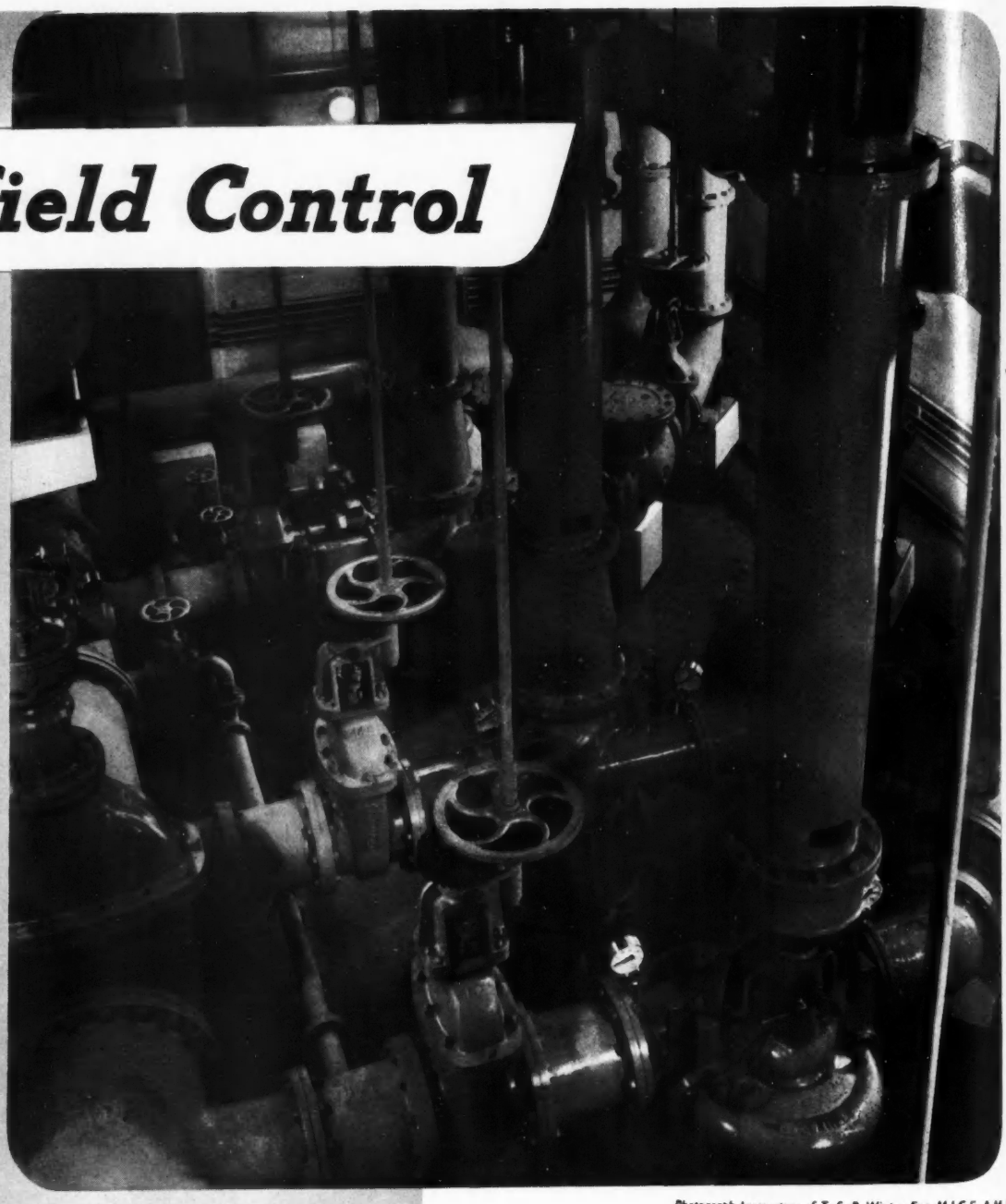

*Photograph by courtesy of T. S. R. Winter, Esq., M.I.C.E., A.M.I.W.E. Engineer and General Manager, Tees Valley Water Board.*

# VALVES

**The photograph shows the Pump Chamber of Low Worsall Pumping Station, Tees Valley Water Board, in which all the water control valves are of Glenfield design and manufacture.**

**Included in the illustration are a 27in. dia. electrically operated Sluice Valve, 12in. and 14in. dia. hand operated Sluice Valves arranged for operation, through spur gearing, in the chamber or from the control room above, 12in. and 16in. dia. " Recoil " Valves and a 6in. dia Pressure Retaining Valve.**

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THE ENGINEER

FEBRUARY 11, 1955

### National Research Development Corporation

THE report of the National Research Development Corporation for the year ended June 30, 1954, records the progress made with the projects started since the Corporation was established five years ago. Electronic digital computers, the report says, constitute the largest single project, on which over £325,000 has been expended. Public expenditure on computers in the U.S.A., it is stated, is believed at present to be many times that undertaken in this country, but, the report observes, British technologists are nevertheless holding their own. Six big computers of the Manchester University type have been or are being built to the Corporation's account, and five of them have already been sold. The report also notes the completion of the trials of the 401 Mark I computer, which has been transferred to Rothamsted Experimental Station and is in routine use for calculations related to agricultural statistics and other purposes. The Corporation continues to support the laboratories at Manchester and Cambridge with grants for the training of computer engineers who will be absorbed into the industry. In general, the report adds, the Corporation intends to give this inventive field its full support for some time to come. The report goes on to say that tape recorders for use in conjunction with computers appear to be a necessary piece of auxiliary equipment and the Corporation has therefore commissioned a number of them to be made to a design based on that of the Mathematical Laboratory, Cambridge. During the year reviewed in the report, 664 inventions were communicated to the Corporation and the rights in 375 United Kingdom patents and applications were formally assigned to the Corporation. Thus, at June 30th last, the Corporation was the owner of 2647 United Kingdom and overseas patents and applications which it administers.

### Loch Glashan Hydro-Electric Scheme

THE North of Scotland Hydro-Electric Board has announced details of its Loch Glashan hydro-electric scheme (constructional scheme No. 71), which will produce 17,600,000 units of electricity annually. The scheme will harness the waters of Loch Glashan, which lies north-east of Lochgilphead among the hills behind the hamlet of Lochgair, on Lochfyneside in the County of Argyll. The natural catchment area of the loch is 4 square miles ; the run-off from a further 20¼ square miles of catchment will be utilised by diversion aqueducts. All the water will be stored behind a dam, 1100ft long and 45ft high, to be built at the outlet of Loch Glashan. From the dam, water will be led by a tunnel and pipeline 5500ft long, to a power station with a capacity of 4·2MW, situated on the shores of Loch Gair. The turbo-alternator set, which will operate under a head of 356ft, will discharge into Loch Gair. The Board states that the scheme is required to help meet the rapidly growing demand for electricity in the Kintyre and Knapdale areas ; the scheme will meet this growth of load for a time, but already further installations are being considered, which may be in the form of an extension of the Highland grid from the Shira scheme, near Inverary, to Kintyre.

### Tummel Valley Additions Scheme

LAST week the North of Scotland Hydro-Electric Board published particulars of its Tummel Valley Additions Scheme—Constructional Scheme No. 31—which provides for the construction of two new power stations with a total capacity of 3900kW. One of these stations will be built on the eastern shore of Loch Ericht at the outlet of the existing tunnel from Loch Garry to Loch Ericht, part of the Rannoch section of the Grampian power scheme. This station will utilise the difference in level—a maximum of 180ft between the two lochs—and it will produce 9,000,000 units annually. The second power station will be built on the Allt Cuaich in Glen Truim to use the difference in level of 87ft between Loch Cuaich and the upstream end of an existing aqueduct which leads water from the Allt Cuaich to Loch Ericht. It will have a capacity of 2400kW and an annual output of 9,300,000 units. The scheme also includes the diversion of several burns to the Board's reservoirs. Under it the Allt an-T-Sluie, one of the headwaters of the River Truin, a tributary of the River Spey, will be diverted to Loch Ericht. The headwaters of several tributaries of the River Tummel will be diverted to Loch Errochty, a new loch being formed in Glen Errochty by the Tummel Garry scheme. These diversions will give a yearly output of nearly 10,000,000 units of electricity. The 3 miles long aqueduct which leads water from Dunalastair reservoir to the Tummel Bridge power station is also to be enlarged and the water level raised to increase the output of the station.

### Karnafuli River Model Investigation

THE Hydraulics Research Station at Wallingford has contracted to carry out an investigation of the Karnafuli River and Port of Chittagong for the Government of Pakistan, under the auspices of the technical co-operation scheme of the Colombo Plan. Chittagong is being developed as the main port of E. Pakistan, and conditions in the river must be improved if the port is to expand and offer suitable facilities for world shipping. There are two main problems to be investigated. First, where the Karnafuli River flows into the Bay of Bengal, the depth of water over the outer bar must be increased, and, secondly, in the tidal reaches of the river at, and immediately above, Chittagong, the rapid fluctuation of the channel meanders must be stopped and the channel position stabilised alongside the shipping jetties. To study these problems a large mobile-bed model of the Karnafuli River from the sea to its junction with the Halda River, some 20 miles upstream, will be constructed in the new main hall at the Hydraulics Research Station. The model will have a horizontal scale of 1/750, and its overall length will be approximately 200ft. A considerable portion of the coastal area around the mouth of the river will have to be included in the model, and the coastal currents and tides will have to be reproduced to study conditions leading to the formation of the outer bar. Data are at present being collected by the port authorities at Chittagong. The design of the model, and of the complex mechanism required to produce and synchronise the tides and coastal currents, is in progress at Wallingford.

### Lloyd's Register of Shipping

LLOYD'S REGISTER OF SHIPPING has issued its "Notes on Statistical Tables, 1954," in which the principal merchant fleets of the world are compared with 1953. The gross tonnage of steamships and motorships in the world amounted to 97,422,000 tons, an increase of 4,070,000 tons, and the largest increases relate to the fleets of Liberia, Norway, Germany, Great Britain and Northern Ireland, Italy and Japan. The Liberian fleet, totalling 2,381,000 tons, represented an increase of 947,000 tons, while Norway increased its tonnage by 542,000 tons to 6,805,000 tons, and the German total rose by 477,000 tons to 2,226,000 tons ; the fleet of Great Britain and Northern Ireland increased by 430,000 tons to make the total 19,014,000 tons, and Italy added 343,000 tons to raise its fleet to 3,798,000 tons, while the corresponding figures for Japan were 327,000 tons and 3,578,000 tons. A preponderance of ships between 6000 to 8000 tons reflects the wartime building programme, but ships built during the last five years are of between 10,000 to 15,000 tons, of which 82 per cent are oil tankers, while of the ships in the size group 15,000 to 20,000 tons and less than five years old, 91 per cent are oil tankers. Since 1953 oil tanker tonnage has increased by 2,660,000 tons to a total of 24,624,000 tons, which represents 25 per cent of the world total of steamships and motor ships, 1 per cent more than the previous year, and compares with 17 per cent in 1939. The following are the principal oil tanker fleets :—Great Britain and Northern Ireland, 4,955,000 tons ; U.S.A., 4,595,000 tons ; Norway, 3,795,000 tons ; Panama, 2,312,000 tons ; Liberia, 1,696,000 tons ; Italy, 1,144,000 tons, and France, 964,000 tons. Motorships increased by 2,817,000 tons, and now represent 33 per cent of the total world tonnage, compared with 31 per cent in 1953, and large oil tankers are mainly responsible for the increase of 2,011,000 tons in the total of turbine-driven ships. There are wide variations in the percentage of motorships in the various fleets. In Norway, motorships account for 81 per cent of the tonnage, and the corresponding percentages for Denmark, Sweden, Great Britain and Northern Ireland and Greece are 80, 79, 41 and 5·5. Oil as fuel is used in 89 per cent of the total steam and motor tonnage, leaving only 11 per cent dependent upon coal, compared with 45 per cent in 1939 and 97 per cent in 1914. At the end of June, 1954, 10,012 ships of 41,235,600 tons gross and representing nearly half of the world total at that date, were entered in the Register Book to the Society's classification.

### Annual Dinner of the Institute of Refrigeration

ON Wednesday of last week the Institute of Refrigeration held its fifty-fifth anniversary dinner, which was attended by about 450 members and their guests, at the Savoy Hotel, London, with the president, Sir Charles G. Darwin, K.B.E., in the chair. Monsieur Rene Varin, the Cultural Counsellor of the French Embassy, who deputised for Monsieur Massigli, who was until recently the French Ambassador, gave the toast of The Institute of Refrigeration. He recalled the difference in Atlantic travel made by the introduction of refrigeration and went on to mention the value of deep freezing in surgery. After referring to the Refrigeration Congress to be held in Paris this year at the Institut International du Froid, Monsieur Varin went on to say that the syllabus for the diploma of the Institute was on a sound basis and that the diploma was recognised in Holland, Belgium and France. Sir Charles Darwin responded and said that the Institute had pleasant memories of the eighth Congress held in England and would be strongly represented in Paris. With regard to the announcement, made last year, that the British Refrigeration Association had provided funds for research, he was pleased to announce that the research scholarship had been awarded and that work was proceeding. Sir Charles went on to point out that it was traditional to engage in three years study at a university ; this period, he emphasised, was not enough for technological subjects. Students in other countries spent more time at college and industry must be prepared to make a larger investment in the subject of refrigeration in order that enough students would come forward and so convince the universities of the need for an extended course of study. Sir Charles concluded by announcing that he was relinquishing the presidency and that Lord Dudley Gordon had been nominated as his successor.

# Safety in Industrial Radiography

By V. E. PULLIN, C.B.E.

*This article deals in general terms with the necessity not only for adequate precautions in the ever-increasing uses of X-rays and radioactive agents in industry, but also with the emphasis that should be given to the fact that strict obedience to protective rules does entirely eliminate the dangers which potentially exist. The article is written in general terms. It is intended to emphasise the importance of protection in all places where radiography and radiology are applied in industry.*

QUITE recently an industrial radiographer suffered from very serious injury as the result of an X-ray burn. This particular incident renders it not inopportune to consider and re-emphasise the vital importance of adequate precautions in all organisations, rooms and laboratories where radiography is carried out by means of X-rays or any of the radioactive substances.

These remarks apply also to laboratories and rooms where radioactive materials may be used in the course of research or in any branch of production activity.

The onus is on any firm or organisation which employs radioactive methods, either for radiography or for any other purpose in the course of their activities, to provide, for the safety and well-being of their staff, whatever protection, protective appliances, information or conditions may be reasonable at any given time. Such provisions will be, of course, governed by the extent of the general knowledge of the art at any given time and also in relation to what is common practice in similar institutions.

The dangers inherent in radiological practice are complicated by the fact that radiation from X-rays or gamma rays is invisible, and, moreover, if an X-ray or radioactive material burn is suffered by an individual the consequences are not immediately appreciable as they would be in the case of a burn by ordinary heat or injury by moving machinery.

One of the sources of danger to be apprehended in this work is that of familiarity breeding contempt. There is no question that long experience in any particular work may produce the carelessness which is so often associated with familiarity. It is to be hoped that such cases in radiography are rare, but, nevertheless, the fact that they are potentially present is ample reason for warning personnel of this aspect of their work in the general book or list of rules which will be suggested later.

There is in existence a highly important and authoritative body known as The International X-ray and Radium Protection Commission. This organisation is international in character and from time to time has laid down rules governing the use of X-rays and radioactive materials in industry. The last revision of these rules was in 1953.

Although the rules and regulations laid down by this Commission have so far no statutory authority they have the overwhelming advantage of being the result of international agreement and universal acceptance.

It would seem desirable that every radiographer and person having industrial dealings with X-rays should be furnished with a copy of these recommendations or, at any rate, an extract from them concerning the nature of the work he or she is engaged upon.

In addition to the necessity for disseminating these general regulations about the uses of radiation, each firm using this method of investigation would do well to have a set of rules of their own containing various additions and modifications to the general regulations as are called for by their own particular organisation, work or conditions. For example, the storage and technique pertaining to radiographic isotopes vary quite differently between one works and another, and the methods adopted by any particular firm should be incorporated in their own safety rules.

Further, in order that there should be evidence that each member of the radiological staff has read and understood these documents, his signature should be obtained by his employer certifying that he has in fact been furnished with a copy of the relevant rules and has both read and understood them.

The use of X-rays generally in industry, and particularly in engineering, has extended enormously in recent years. It is still continuing to extend because of its proved value and because of the recent free availability of radioactive isotopes. This development is from many points of view a very great boon to industry and the loss or diminution of it would be a very serious handicap in many spheres. It is therefore greatly to be hoped that no major accident shall ever occur which might conceivably tend to discredit this work or to hamper in any way its progress.

It is therefore of the utmost importance that while stressing and emphasising the inherent danger of the work, it is equally vital that no element of fear in workers should be engendered or encouraged. Consequently, hand-in-hand with the emphasis that should be placed upon care and protective measures, so it should be emphasised that if proper and intelligent care is taken rigorously to observe the rules that are laid down, all the dangers may be eliminated.

It is fairly common practice to display notices with the word " Danger " in large letters where radiographic work is in progress in order to warn people in the vicinity to keep away from this area. These notices are particularly directed to those members of the staff who are not radiologically trained and to casual visitors.

Wherever possible—that is, where a particular room is allocated to radiography and where the X-ray tube is housed, the controls being outside the room—in addition to the adequate protection that is required for walls, ceilings, cracks, &c., the door should be fitted with a trip switch in such a way that when the door is opened the X-ray tube is switched off.

It is not possible to put this suggestion into operation, for example, in the case of a boiler shop and some other works where it is necessary to move the X-ray set, or the radioactive material, about from place to place for the examination of large structures. In cases such as this adequate space should be roped off to restrain casual visitors from approaching the source of radiation.

It has been suggested that protection might be the subject of closer supervision of personnel. This appears to be difficult to achieve. In very many firms there are only one or two radiographic experts and the whole of their time is taken up in doing their own work and it is rare to find in any technical firm general staff with the necessary specialised knowledge or the time to carry out adequate supervision. We are therefore forced to rely upon not only the skill and knowledge of the operator, but upon his own personal integrity which again suggests that far more care should be used in the selection of " trainee radiographers " than has been exercised in the past.

Blood counts should be carried out in accordance with the recommendations of the International Commission. They should be done by an independent and experienced pathologist and wherever possible his report should be submitted to the works doctor whether it appears to the layman to be favourable or not.

The International Commission has been able to lay down certain doses, within given periods, which are calculated to be safe under all conditions. There is no doubt about the definition of the quantity of radiation that may be received in a given time. The difficulty as it presents itself to the firm, or the operator, is how these dosages may be reliably measured. There are two ways in common use whereby this end is achieved. The N.P.L. have an admirable system of using (attached to the person of the operator) small films which are periodically returned to the laboratory and are developed under conditions of precision, thus enabling the dosage to be calculated from the comparative blackening of the film.

There is one point concerning the use of the films which the writer would like to see in general practice. It is obvious that in working either with an X-ray set or radiographic isotopes the part of the body which is most likely to be placed in a dangerous position relative to the emerging rays are the hands : it is quite conceivable that a film or ionisation chamber may be worn on the body and fail to show quite a large dose of radiation received by the hands alone.

It is therefore suggested that to meet this contingency N.P.L. films should be worn bracelet fashion, one on each wrist, and fastened by means of elastic bands. In addition, it is now commercially possible to obtain pocket dosemeter chambers which may be carried on any operator throughout the period of his duty. Such chambers are neat and compact in design and have the advantage of being graduated in röntgens or fractions of a röntgen, which is the unit defined for the measurement of dosages.

In the opinion of the writer, such chambers should be worn by every member of any radiographic staff and it should be the business of one competent individual to read these chambers at the close of each day's work and to enter the record in a book under the appropriate worker's name. The same man who looks after these records should be given the responsibility of seeing that the instruments are properly charged before the start of each day's work.

To many of us who are experienced in this work these notes may appear to be trite and even redundant, but maybe they are not. Most of the literature concerning protective apparatus and rules in radiography comes into the hands of the operators —at the best, into the hands of managers or sub-managers of departments. The executives in charge of any works, particularly large works using radiography extensively, should personally be perfectly familiar with their responsibility in dealing with this highly specialised and technical matter.

There is no excuse for anybody who may desire to plead ignorance. Full information may be obtained immediately on request to the N.P.L. With regard to radioactive materials, the Atomic Energy Research Establishment at Harwell, has a system by which information may be obtained on application.

# Improvements in Direct Current Traction in France

By B. K. COOPER

*The French National Railways are obtaining running experience with two designs of 80-ton, four-axle electric locomotives rated at 4000 h.p. and suitable for the widest possible range of duties on the main lines electrified at 1500V d.c. Their performance is being studied with a view to standardising this wheel arrangement for the work now done by larger and heavier six-axle locomotives, and some of their mechanical features are being incorporated already in designs for the 50-cycle a.c. system. Certain details of electrical equipment and cab layout are common to both prototypes and have been introduced also in new multiple-unit rolling stock.*

DEVELOPMENT of single-phase traction at the industrial frequency on the French National Railways has not been allowed to retard progress in the design of equipment for the extensive mileage operated at 1500V d.c., which now totals 2435 route-miles. By the time the Paris-Lyons electrification was completed in 1952 the decision had already been taken to build no more of the 2-$D_0$-2 (fixed four-axle driving wheel-base) locomotives which had previously been the normal type for main line express work in France, but to concentrate on designs with motor bogies and no non-motored guiding axles. The first of these had two three-axle bogies ($C_0$-$C_0$), and after successful trials with two prototypes a series of fifty-eight was ordered. One of this class, No. 7121, achieved the world rail speed record of 243km (151 miles) per hour on February 22nd last year.

Meanwhile the possibilities of using a lighter four-axle ($B_0$-$B_0$) locomotive with a similar performance to the $C_0$-$C_0$ had been studied. Four prototypes were ordered, two with mechanical features derived from Swiss practice (Fig. 1) and two of wholly French design (Fig. 2). All four are now in service and hauling express trains on the fastest schedules as well as goods traffic. Some particulars of the $C_0$-$C_0$ and the two $B_0$-$B_0$ classes are tabulated below for comparison.

| Class | 7100 | 9001/2 | 9003/4 |
|---|---|---|---|
| Wheel arrangement | $C_0$-$C_0$ | $B_0$-$B_0$ | $B_0$-$B_0$ |
| Builder (mechanical parts) | Alsthom | S.L.M. | M.T.E. |
| Electrical equipment | Alsthom | Brown-Boveri | S.F.A.C. Jeumont, Oerlikon, Schneider-Westinghouse |
| Length overall | 62ft 1in | 50ft 7in | 53ft 2in |
| Adhesive weight | 104¼ tons | 78¾ tons | 78¾ tons |
| Horsepower (continuous)* | 4356 | 3990 | 4010 |
| Horsepower (one hour)* | 4752 | 4435 | 4455 |

* At 1350V

The use of four-axle locomotives weighing under 79 tons on duties as severe and varied as those of the Paris-Lyons main line is still to be regarded as experimental, and on being invited recently to ride as far as Dijon in the cab of the "Mistral" express, I was exceptionally lucky to find one of the new $B_0$-$B_0$ prototypes of French design at the head of the train. Before describing the run, certain mechanical and electrical features of these locomotives must be mentioned because of their bearing on the problems of achieving the desired performance with a limited adhesive weight. Moreover, the locomotive must show the same stability at high speed as its six-wheel bogie predecessors, and give no more punishment to the track in spite of its heavier axle load.

When the $C_0$-$C_0$ class appeared, considerable attention was attracted by its unusual bogie pivoting arrangement, consisting of two normally vertical links connecting each bogie with the frame, which swing in opposite directions to permit a turning movement. An entirely new system is adopted in the modified Pennsylvania bogies (Figs. 3 and 4) of Nos. 9003 and 9004, the two French-built prototypes. There is no pivot in the ordinary sense, but the bogie can swivel under the bolster, which rests on oil-lubricated bearing surfaces. A system of longitudinal and transverse links with Silentbloc mountings maintains the body, bolster, bogie frame and the assembly of equalisers and axles in their correct relative positions. One result of these linkages is that it is unnecessary to locate the spring-suspended bogie frame over the equalisers by means of the usual axlebox guides. The axleboxes are carried in the equalisers by annular mountings constructed on the Silentbloc principle.

The gear case forms one side of the bogie frame, which is located laterally by the cardan shaft transmission itself, consisting of a hollow shaft surrounding the driving axle and flexibly attached at one end to the final gear wheel and at the other end to the running wheel at the opposite side of the bogie. Tractive effort is transmitted to the bogie frame through links connecting it with the equalisers, and from the frame to the body by a system of horizontal drawbars attached to the body in approximately the same plane as the axles. The effect is to minimise weight transfer between the axles of a bogie at starting so that the most effective use is made of the adhesive weight, as is essential in a relatively light locomotive capable of exerting a maximum tractive effort of nearly twenty tons.

On the electrical side the locomotive has a multi-notch control system with the advanced degree of field weakening characteristic of French practice since the war. Five weak-field notches, with a minimum of 30 per cent, are available in both motor groupings (series-parallel and parallel). The forty resistance notches provide a fine control of tractive effort which combines with the mechanical features already mentioned to counteract a tendency to wheelspin when starting heavy loads.

When I joined locomotive No. 9003 at the Gare de Lyon I found the "Mistral" composed of twelve coaches weighing 577 tons in all. The moderate length of the $B_0$-$B_0$ design is accentuated when the locomotive is seen coupled to a train of main line stock of this size, but far from giving an impression of inadequacy it leads the observer to admire the technique which has packed such capacity for work into limited dimensions. The "Mistral" is allowed only 152 minutes for the non-stop run of 195·3 miles to Dijon (77·1 m.p.h.), and reaches Lyons in 250 min for the 317·5 miles with one stop, an overall average of 76·2 m.p.h. Here the electric locomotive comes off, with more than half its daily stint of some 745 miles still before it.

The few minutes before departure gave an opportunity to study the driving arrangements. An unusual feature of the controller handwheel is that it is moved to and fro for notching up, first between two points on the series-parallel sector of the face plate and then between two points on the parallel sector. Transition occurs automatically as the handwheel is advanced from one sector to the other.

Each to-and-fro action of the handwheel causes the Jeumont-Heidmann electrically-driven camshaft to advance one notch. There are, however, other controller positions which cause the camshaft to rotate continuously through all the notches up to series-parallel or parallel as required. These are used for restoring power after coasting. Similar step-by-step or continuous action is

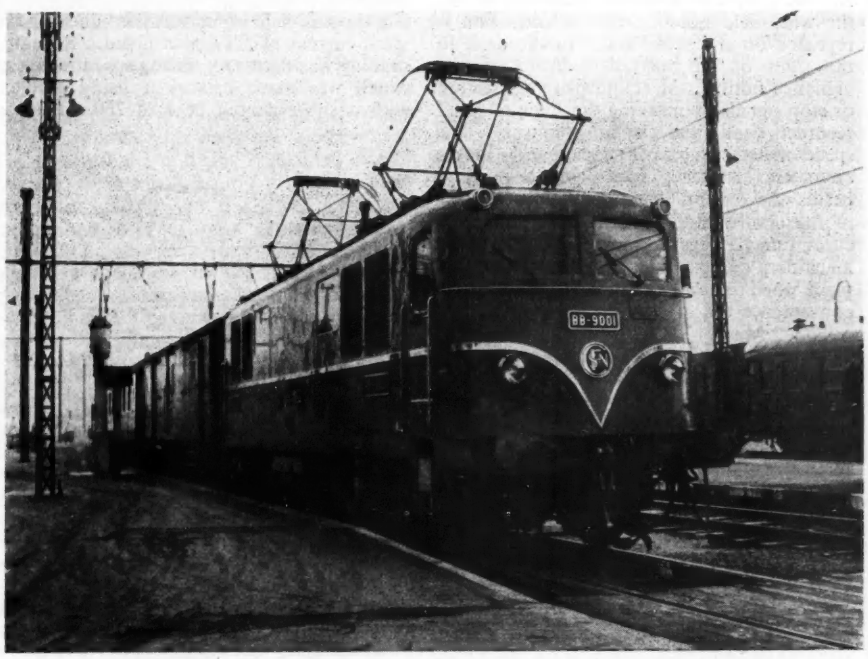



**Fig. 1—BB-9001, one of the two Swiss built $B_0$-$B_0$ high speed prototype locomotives**

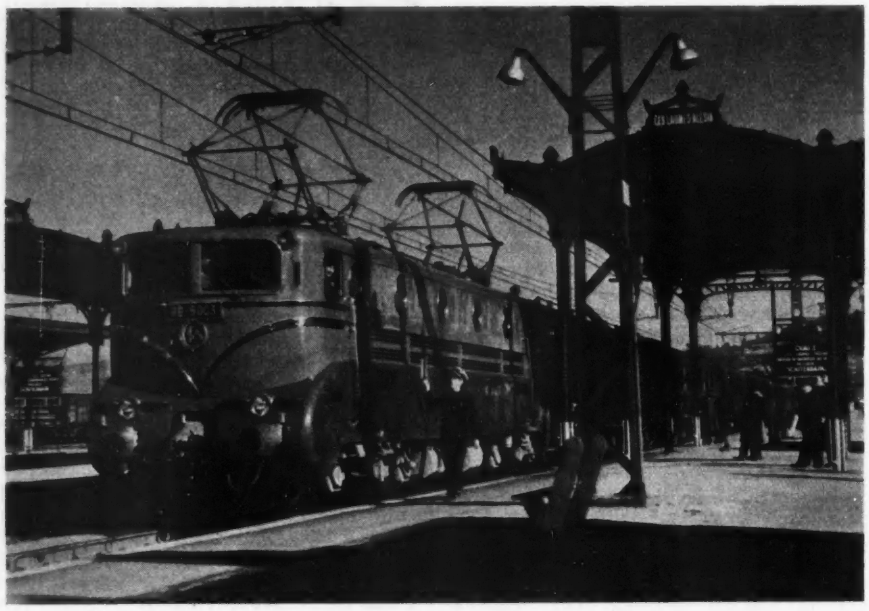


Fig. 2—BB-9003, the first of the French designed $B_0$-$B_0$ high speed prototype locomotives

available for notching back. A large dial and pointer in the centre of the cab show the driver the notch in which he is running at any moment, and in my opinion do so more clearly than the usual closely graduated face plate or quadrant below the controller handle. There is a separate lever for selecting the weak-field notches, but its operation is repeated on the same dial. In the desk to the right of the weak-field lever are the vigilance button (for acknowledging caution or stop signals by marking the Flaman speed recorder band) and the horn button. The speedometer, line voltmeter, and motor ammeters are easily read from a position beside the driving seat. A built-in ashtray in the control desk and a cloakroom with chromium hatpegs between the cab and the machinery compartment do not seem out of place when associated with a layout in which convenience has so clearly been studied.

The " Mistral " pulls out on its run to Nice at 1 p.m. On this occasion greasy rails as a result of rain would have made some slipping excusable in a four-axle locomotive hauling nearly 600 tons, but there was no sign of it. Should it occur, it is detected automatically and indicated by warning lamps on the driver's desk, while further notching-up is prevented. Four minutes from the start we were in full parallel, full field and running at 50 m.p.h. The current, which during notching had remained well below the permitted figure of 800A per motor, was now 500A and the driver went into his third weak-field notch for further acceleration. A speed limit of 75 m.p.h. through the suburban area to Combs-la-Ville, however, made it necessary to return to full-field at Villeneuve-St.-Georges, 8·9 miles out, passed at 1.12. Past Brunoy the line climbs at 1 in 200/250 and with the driver alternating between the third and fourth weak-field notches the current again reached 500A with the speed around 79 m.p.h. In steam days drivers used to say that their engines " took a deep breath " on reaching the summit near Lieusaint. The same expression is still used, but is even more apt now that Lieusaint is the site of a substation and the line voltmeter in the locomotive can be seen creeping up as the building comes into view.

On the descent to Melun the driver allowed speed to rise for the first time to the permitted maximum of 140km (87 miles) per hour, and from here until we were checked for permanent way work beyond Laroche he held the speedometer needle steady on the 140 mark by periodical adjustment of the weak-field control, mainly between its first three notches. To accelerate after the slack the fourth weak-field notch was used and a maximum current of 520A was noted. Repeated sanding was necessary during speed recovery, which was made against a rising gradient with a short stretch of 1 in 250. Back at 140 km.p.h., weak field 1 and 2 held the speed steady except for a short spell in the third notch to breast the 1 in 200 between Nuits-sous-Ravières and Aisy, which sent the current up briefly to 450A.

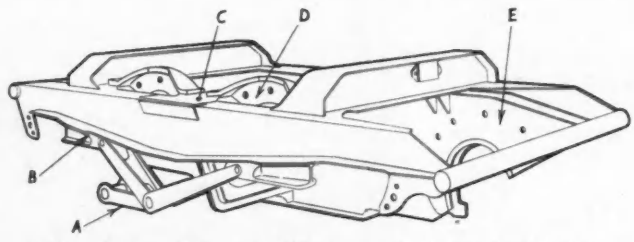
The check after Laroche had put us 2 min behind time by Tonnerre (121·9 miles), although our average so far worked out at 77·8 m.p.h. As the next 37·7 miles to Les Laumes Alésia have to be covered at all but 84 m.p.h., it is not surprising that we had not got back to schedule by that point, which left us with the 35·7 miles over the " hump " at Blaisy-Bas in which to recoup the loss. The timetable allows 33 min for this stretch, of which the first 19·3 miles are on adverse gradients steepening from 1 in 210 to 1 in 125.

We began the climb in weak field 3 at 86 m.p.h. with a current of 400A. After the first 5 miles we were back in full field and drawing 200A, speed being still around 85 m.p.h. Clearly we could have gone into the weak-field notches again without excessive current, for the needle remained between 250A and 350A for the rest of the ascent, but the driver told me he was confident of a punctual arrival, and that he received a bonus for economy in consumption. Consequently he was content to potter over the top at a minimum of 62 m.p.h. The succeeding descent rapidly brought us up to 87 m.p.h. again, and with our heavy train we were able to coast at this speed for much of the remaining 16·4 miles into Dijon, mostly at 1 in 125. We rolled to a standstill accurately at 3.32 p.m.

During the run I inspected the apparatus compartment in the centre of the locomotive. The layout is remarkable for the amount of free space all round the main equipment frame containing the camshaft and resistances. Weight and bulk have been saved in the resistance portion by providing the grids with forced ventilation from motor blowers connected across the last section to remain in circuit, which also removes any limitation on the time for which the resistance notches can be used. A gale blowing round the legs reminds one that the traction motor blowers are delivering some 353 cubic feet of air a second, drawing their supply from longitudinal openings low down in the body sides.

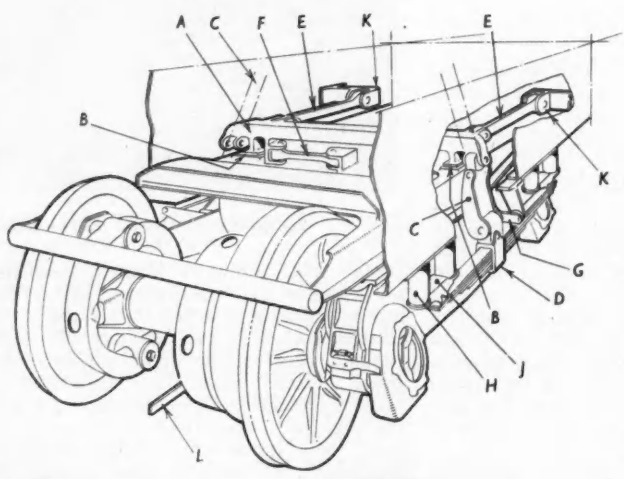
The riding of the locomotive at all speeds was excellent, with no lurching or swaying that would have attracted the notice of a suburban straphanger even when negotiating quite sharply curved turnouts at junctions near Paris, or descending the sinuous section of line from Blaisy-Bas into Dijon.

Recently the second locomotive of the same type, No. 9004, has gone into service. This differs from 9003 only in its traction




*A*—Connection to equaliser. *B*—Side bearer. *C*—Bearing surface for bolster.
*D*—Motor suspension bracket. *E*—Gearcase (incorporated with bogie side member).

Fig. 3—Bogie frame construction




*A*—Bolster.
*B*—Bolster bearing surface.
*C*—Pendulum link.
*D*—Body suspension spring.
*E*—Longitudinal link between bolster and body.
*F*—Transverse link, bolster to body.
*G*—Spring stay.
*H*—Silentbloc damper.
*J*—Bearing surface for dampers
*K*—Attachment to body for *E*.
*L*—Drawbar connection from bogie to body.

Fig. 4—Bogie assembly details

motors, which are built by Schneider-Westinghouse and have no compensating windings, although designed to run with a minimum field of 40 per cent. The motors of No. 9003 are a compensated design by Oerlikon. I had time for a brief inspection at the Charolais depot in Paris of one of the two Swiss-built machines of similar capacity and weight, which are carried on S.L.M. bogies derived from those of the lightweight, high-speed "Re 4/4" class of the Swiss Federal Railways. These locomotives also

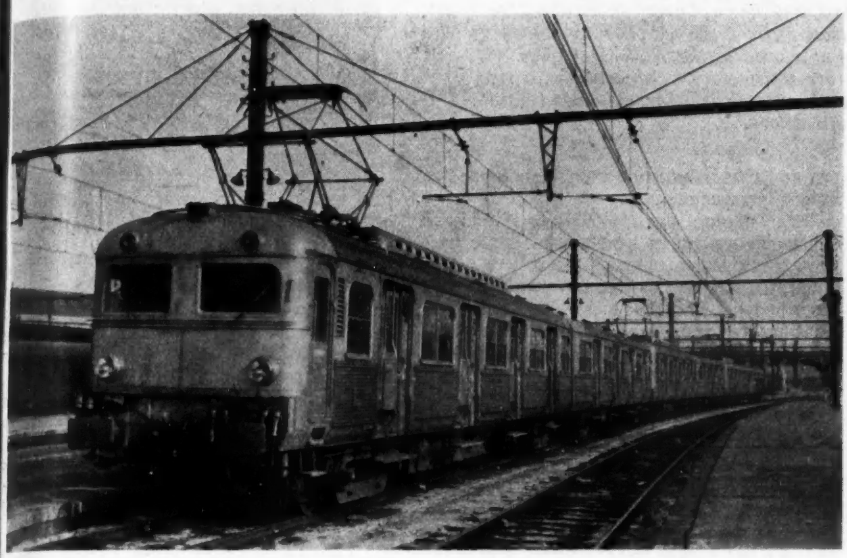


Fig. 5—Multiple-unit stock in service in the Paris suburban area of the South East Region, S.N.C.F.

are equipped with camshaft control and have a similar driving desk arrangement to Nos. 9003 and 9004.

The $C_0$–$C_0$ and mixed traffic $B_0$–$B_0$ locomotives on the Paris–Lyons line have electro-pneumatic contactor control, although the 2–$D_0$–2 class is equipped with the camshaft system of the Compagnie Electro-Mécanique. There is an evident trend at present towards standardising the "JH" type of camshaft and the cab arrangement adopted in the latest $B_0$–$B_0$ prototypes, for these features are reflected in the new multiple-unit stock (Fig. 5) now going into service in the Paris suburban area of the South-Eastern Region. This standardisation extends to items such as the safety interlocks, for in all these units the keys for access to high-tension equipment are stored in the cabs in a common design of cabinet which is unlocked by the pantograph control key, available for this purpose only when the pantograph is down.

Another feature of these new locomotives and motor coaches, in common with earlier designs, is the absence of motor generator sets. The l.t. supplies are taken from a battery which is charged either from the line through a dropping resistance or by being connected in series with a compressor or blower motor.

Although the new motor-coaches have automatic acceleration, the same hand notching facility as in the locomotives is available up to full series, so that ten resistance notches can be used for shunting and slow running as compared with the single shunting notch usual in British practice. One weak-field notch in series and two in parallel combine with the full-field positions to give the driver five economical running speeds. The opportunity is being taken to test various methods of motor suspension by equipping different units with axle-hung motors, spring-borne motors driving through a cardan shaft as in locomotives 9003 and 9004, and nose-suspended motors with a quill shaft enclosing the driving axle and a rubber coupling between the gear wheel and running wheel. It is considered that a departure from the conventional axle-hung, nose-suspended arrangement will be an advantage in stock running at speeds up to 75 m.p.h.

Looking further ahead, it would not be surprising to find automatic acceleration applied eventually to main-line locomotives. The present hand-notching is retained largely because drivers are accustomed to it and prefer it. However, the motor-coaches incorporate an arrangement which automatically adjusts the setting of the accelerating relay according to the load, and it is reasonable to look forward to some similar method, either automatic or manually set, adapted to locomotive requirements.

It is too early to forecast whether in future lightweight $B_0$–$B_0$ locomotives will displace the $C_0$–$C_0$ type for fast main-line work. Replies to the question whether the four-axle design will do all that can be expected of the larger machines are still cautious, although there have been some remarkable performances with heavy loads. $B_0$–$B_0$ 9004, for example, has averaged 79·5 m.p.h. from Lyons to Paris with 814 tons, making good 55 min lost time. Test runs with all four prototypes alternate at intervals with normal service running and are providing data on mechanical and electrical characteristics which will doubtless help in shaping future policy. It is probable that some of the mechanical features will be adopted in the design of main-line passenger locomotives for projected electrifications at 25kV, 50-cycle, single-phase a.c., such as those from Paris to Lille and Strasbourg. The enthusiasm for experiment which characterises French National Railways electric traction practice to-day may well leave its mark in future on countries where the well-tried and the orthodox have hitherto been guiding lights.

ACKNOWLEDGMENTS

Design of the new locomotives and rolling stock has been inspired and guided by Messieurs M. Garreau, F. Nouvion, M. Lothon and M. Tessier, of the electric traction development division, and their operation is under the supervision of M. Jacquemin, chief of development.

My guide on the journey and visits of inspection here described was Monsieur Pierre Patin, now head of the carriage and wagon section of the rolling stock and traction department, South-Eastern Region. As the author of a book which has become a standard medium of instruction for French railway staff studying electric traction, Monsieur Patin can justly claim a share of credit for the technical knowledge and keen interest in their subject displayed by the locomotive crews whom I met on my visit. My thanks are due to him for the arrangements which enabled me to see and learn so much in a short space of time.

Figs. 3 and 4 are published by courtesy of the *Revue Generale des Chemins de Fer*.

## Carbides in Low-Chromium Steels

DIVERGENT results have been obtained in attempts to identify the carbides in annealed low-chromium steels, though it is generally agreed that the carbide in chromium steels containing up to 2 per cent of chromium possesses the crystal structure of cementite, some iron being replaced by chromium; whilst, in the 3 per cent chromium steel, F. Wever and W. Jellinghaus[1] identified the trigonal carbide, $Cr_7C_3$, in addition to cementite. W. Tofaute, A. Sponheuer and H. Bennek[2] limited the co-existence of the $Cr_7C_3$ and the cementite structures to a very narrow band of compositions around 3 per cent chromium. To carry the matter further, F. Wever and W. Koch[3] have recently studied the isothermal transformation of a chromium steel containing 0·4 per cent of carbon and 3·5 per cent of chromium. This steel consists of homogeneous austenite at temperatures of 1050 deg. Cent. and over, and on isothermal transformation to the equilibrium condition in the pearlite range it shows the ferrite and chromium carbide, $Cr_7C_3$, structures only. According to their observations of the austenite-pearlite transformation, based on micro-analysis and X-ray crystallographic study of residues separated by electrolysis, the carbide which first separated had the structure of $Fe_3C$ in which about 30 per cent of the iron atoms were replaced by chromium. Immediately after the formation of this carbide, its transformation to the stable carbide, $Cr_7C_3$, sets in. This transformation is complete after about one day at 730 deg. Cent. or longer at a lower temperature. During this process the chromium content of the carbide increases progressively, but at the end of the transformation about half the chromium atoms in the carbide, $Cr_7C_3$ are still replaced by iron.

This work has been supplemented by Angelica Schrader[4] who, in a paper illustrated by some excellent optical and electron micrographs, has recorded the microstructures observed in the pearlite transformation of the same steel at the upper (675 deg. to 730 deg. Cent.) and lower (about 600 deg. Cent.) pearlite ranges. In the upper range, the transformation starts from nuclei situated, for the most part, in the grain boundaries and the pearlite grows equally in all directions. In the lower range, the pearlite forms from nuclei within the austenite grains, and develops in long, slender branches with lateral ramifications between which the remaining austenite then transforms. An outstanding feature of the paper is the illustration of the structural features associated with the isothermal transformation, in the pearlite, of the first formed $Fe_3C$ (containing chromium) into $Cr_7C_3$ (containing iron). These serve to amplify and confirm the findings of Wever and Koch.

[1] *Mitt. K.-W.Inst. Eisenforschung*, 1932, Vol. 14, page 105.
[2] *Archiv f.d. Eisenhüttenwesen*, 1934–35, Vol. 8, page 499.
[3] *Stahl und Eisen*, 1954, Vol. 74, page 989.
[4] *Archiv f.d. Eisenhüttenwesen*, September/October, 1954, page 465.

LAUNCH OF INSHORE MINESWEEPER.—On January 11th the inshore minesweeper, H.M.S. "Riplingham," was launched from the shipyard of Brooke Marine, Ltd., at Lowestoft. The ship is of all-wood construction and has a length of 106ft 5in by 20ft 6in beam.

# Compressive Stress-Strain Properties of Thin Sheet Material

By K. C. ROCKEY, M.Sc., A.M.I.Mech.E., and F. JENKINS, B.Sc., Ph.D..

*This note, prepared initially for the Aluminium Development Association, describes a testing rig which has been successfully employed in obtaining the compressive properties of thin sheet material. Some time ago, the writers had to determine the compressive properties of some thin sheet in order that the experimental results obtained from tests on model girders could be analysed. Now, since a number of different methods have been used in the past, a review was made of the available technical literature to determine which of these methods seemed the most suitable. This review clearly indicated that the rig developed at the National Bureau of Standards[1] was the one most likely to prove satisfactory. Subsequently, a rig based on this design was made and, subject to certain conditions discussed below, has proved satisfactory.*

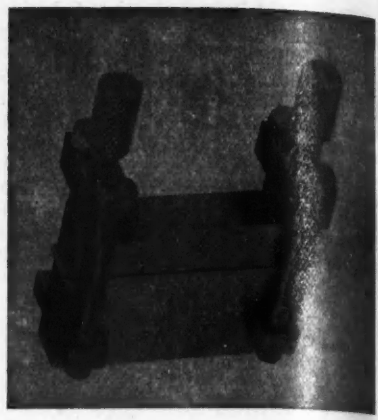


Fig. 4—Testing rig assembled

THE main difficulty encountered in conducting a compression test on thin sheet material is that of providing the specimen with suitable lateral support. For a number of years, the pack method[2,3,4,5] has been successfully employed. In this method, a number of specimens are cemented together to form a single block which is supported laterally during a test by a number of horizontal guide rods. The main disadvantage of this method is that a large number of accurately machined specimens have to be prepared for each test. In addition, the setting up of the specimen and the accompanying guide bars in the testing machine takes some considerable time. To overcome these disadvantages, Montgomery proposed that

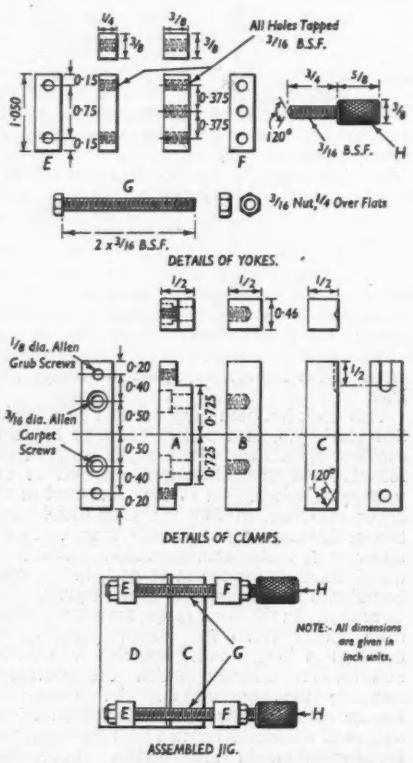



Fig. 1—Details of components of testing rig to obtain compressive properties of thin sheet material

single specimens should be used instead of the pack method. As a result, a rig was developed[6] in which the single specimen was supported by 0·093in diameter rollers spaced at 0·1in centres along the length of the specimen. Unfortunately, it was discovered that the unsupported end of the specimen tended to bend sideways during a test and that in addition the rollers tended to indent the specimens.

To overcome these difficulties Aitchison[7] constructed a rig in which solid guide bars were employed in place of the rollers. This apparatus proved satisfactory and the rig described by Miller[1] is a development of it. At about the same time La Tour and Wolford[8] developed a similar rig and obtained good results with it.

## Description of the Apparatus Developed at the National Bureau of Standards

The apparatus consists of two hardened steel blocks *C* and *D*, between which the specimen slides (for design details see Fig. 1). Block *D* consists of two smaller blocks *A* and *B*, which are connected together by two Allen screws. Blocks *C* and *D* are held together by the slender bolts *G*, which pass through the cross bars *E* and *F*. Although the bolts are strong enough to hold the apparatus together, they do not seriously restrict any expansion of the specimen due to Poisson's ratio effects. It will be noted that the holes in the cross members *E* and *F*, through which the bolts pass, are tapped. This ensures that the yoke is stiff and free from relative movements. In order to reduce the distance between the cross members *E* and *F*, it is necessary to unscrew one bolt and then to rotate the cross members *F*.

On assembling the apparatus, block *C* is correctly positioned relative to block *D* by means of the knurled screws *H* which fit into a grooved seat near the top of the block and a conical seat at the bottom. The details of the blocks and yokes can be clearly seen in Fig. 3, which gives an exploded view of the apparatus. Fig. 4 shows the apparatus assembled. It will be noted from Figs. 1 and 4 that the specimen extends a small distance (0·05in) beyond the blocks *C* and *D*, thus ensuring that only the specimen carries the axial load. The specimens are 2·25in long by 0·5in wide, and are therefore of similar proportions to the normal tensile specimen. Since the specimens are 0·04in wider than blocks *C* and *D*, extensometers can be attached to the edges of the specimen.

Care must be taken to ensure that all holes are correctly positioned. For this reason it is recommended that blocks *A* and *B* should

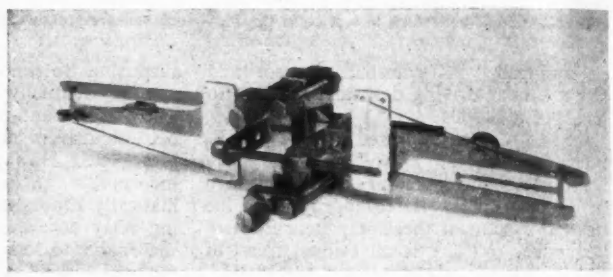


Fig. 2—Testing rig showing extensometers attached to the specimen

be drilled when clamped together, and that the cross members *E* and *F* should be drilled and tapped when clamped together. All plane surfaces of the rig should be ground to size, with a permissible tolerance ±0·001in.

In order to obtain satisfactory results it is essential that the ends of the specimens shall be ground parallel to one another and square to the longitudinal axis of the specimen.

## Testing Procedure

The testing procedure adopted by the writers was similar to that recommended by Miller. The surfaces of the specimen and the guides were first coated with a film of rape oil. The specimen was then placed between the guides *C* and *D* and the knurled screws tightened until the specimen was firmly clamped between the guides. The degree of clamping was considered satisfactory when the specimen could be moved relative to the guides when subjected to light finger pressure. The strain in the specimen was recorded using a pair of Huggenberger extensometers, each having a gauge length of 1in. The method by which the extensometers were attached to the edges of the specimen is shown in Figs. 2 and 5.

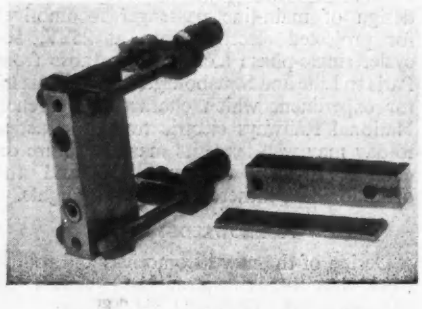


Fig. 3—Exploded view of testing rig

Since it is essential that there shall be no lateral movement of the loading head relative to the specimen, some form of sub-press is required. A very good sub-press was available and was used in the initial tests. Unfortunately, these tests indicated that

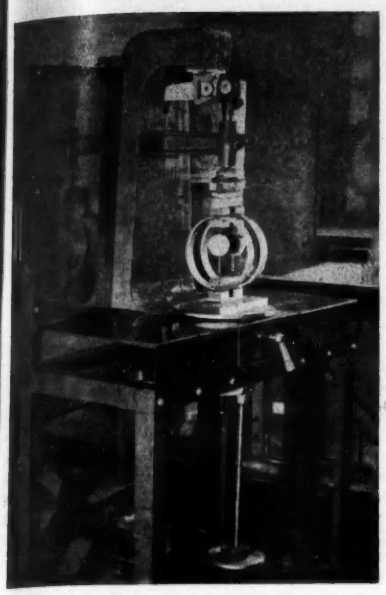


Fig. 5—Testing rig assembled in Oedometer

frictional forces were entering the loading system and so affecting the results. Efforts to determine the exact location of this friction and its magnitude were unsuccessful. The writers therefore decided to employ a load-measuring device either directly above or below the specimen, so that only the friction between the guides and the specimen could affect the results. As will be seen below, this frictional force is of the order of 1 per cent of the applied load. Subsequently, it was decided to adapt an Oedometer for this purpose. The Oedometer was fitted with a guided loading ram and, in addition, there was sufficient space between this loading head and the base to permit the use of proving rings underneath the rig. Fig. 5 shows the rig and the proving rings assembled on the oedometer ready for testing.

Using this apparatus, the writers have obtained good results and Fig. 6 gives the

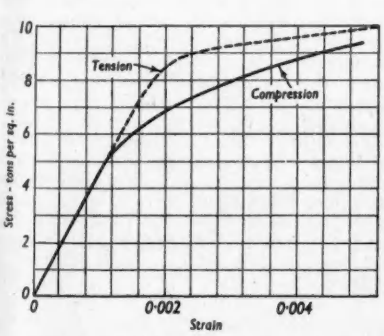



Fig. 6—Mean stress-strain curves in compression and tension

mean curve obtained from a series of tests on NS6 material. This curve may be compared with the tensile stress-strain graph for this material, also shown in Fig. 6. The tests also established that the frictional forces acting between the specimen and the guides *C* and *D* are low. This was illustrated in an actual test by moving the rig relative to the specimen when the latter was loaded into the plastic range. On moving the rig, the axial load of 800 lb as recorded by the proving rings situated beneath the specimen, was reduced by approximately 6 lb.

*Concluding Remarks.*—It has been established that the testing rig described by Miller gives quite satisfactory results and that, as shown by the tests conducted by the writers, the frictional forces acting between the specimen and the guides are very small. Finally, it must be emphasised that if good results are to be obtained, then it is essential that the specimens are accurately machined.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[8] Harry LaTour and Don S. Wolford : "Single-Strip Compression Test for Sheet Materials," American Society for Testing Materials, Vol. 45, 1945, page 671.


# Alarm Clock Factory

## No. I

*The alarm clock factory of Smiths English Clocks, Ltd., at Wishaw, in Scotland, is now producing over 2,000,000 alarm clocks a year. In order to attain this high output extensive use has been made of modern production equipment with specially developed machines for component manufacture and assembly. An elaborate assembly conveyor system is equipped with clock movement assembly fixtures and on it much of the work is carried out whilst the assembly is moving along.*

WITH its output of over 8000 alarm clocks a day the factory of Smiths English Clocks, Ltd., at Wishaw, in Scotland, is probably one of the largest of its kind in Europe, if not in the world. We recently accepted an invitation to visit these works to see how, by the introduction of specialised plant and flow production methods, a very high output has been achieved in the relatively short period of two years the factory has been in operation.

The Wishaw factory was acquired by the company in 1952, when a smaller factory making alarm clocks at Carfin was closed and the staff transferred to lay down the new plant and train additional local labour. The new factory consists of a production floor of some 150,000 square feet, faced by a two-storey office block. In it production is arranged to flow generally from a materials stores at one end and through the machine shops and assembly area to a dispatch department at the far end of the factory. Two large areas are partitioned off from the main floor, one for a large well-equipped tool room and the other for a machine development and building department. A particular advantage in having the tool room near the machine shop is that tools requiring reconditioning can be quickly transferred and responsible personnel can be in attendance when new set-ups are being tried out. The same thing applies when newly developed machines, tools, fixtures, &c., or reconditioned machines are placed in the production lines by the development department.

All incoming materials, before release to the stores, are checked in an adjoining laboratory to ensure that the very close metallurgical and physical conditions laid down have been observed by the suppliers. This close control is an essential part of the works organisation, not only to ensure that the finished product is satisfactory, but also to reduce risk of hold-up in the highly mechanised production lines. A complete record is kept of every batch of incoming material released by the stores, so that in the event of trouble in production the material suppliers and the relevant parts can be readily traced. All materials are batched and stored in stillages ready for issue *en bloc* to the production lines by fork truck. This system is used to eliminate the need for fixed racks and bins, and it gives a large measure of flexibility in making full use of the tores area available.

In the main machine shop component parts of the clocks are produced on batteries of automatics and presses including special purpose machines designed and built by the firm itself.

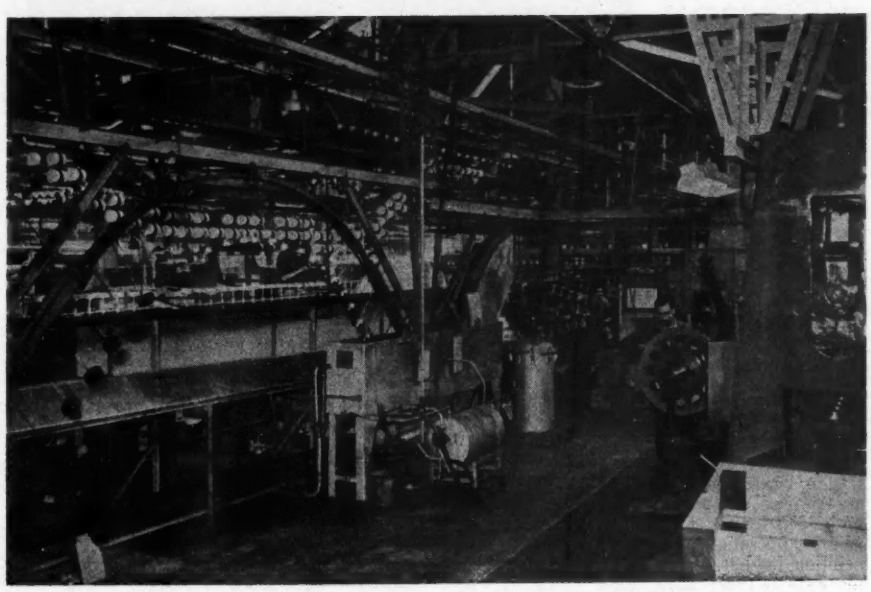


Fig. 1—Clock case press and degreasing station with cases suspended on magnetic holders from an overhead conveyor

Fig. 2—Band conveyor transferring clock cases mounted on painting holders to spraying booths

Fig. 3—Two-station indexing table machine for assembly of centre wheel, spindle and components

In addition to normal checking during component production by the machine setters and operators, the machines are visited at regular intervals by patrol inspectors. Each day's output of a machine is batched separately for transfer to the final inspection, where a statistical sampling check is made. Should more faulty parts be found than meets a predetermined outgoing quality level, the whole batch is detail inspected. To give yet a further check certain critical parts for the clock movements are also withdrawn from each batch and fitted into clocks to run for a period before the batches are released by the inspection department as suitable for use.

It will be appreciated that the very small size of clock components makes possible their ready transfer from inspection to the assembly section. Clock cases, however, present a problem in that they are comparatively large, and to transfer 8000 a day from the production area to the assembly by stillages would present a difficult bulk transport problem. For this reason the case making section is connected to the assembly area by an overhead conveyor system and its arrangement is worthy of special mention.

The clock cases are made directly from coiled strip on the eight-station transfer press, to be seen on the right in Fig. 1. The cases are transported from this press in stillages to the head of a short belt conveyor on the opposite side of the gangway. This belt conveyor passes a series of small power presses, the operators of which remove the cases, date stamp them, and attach certain of the fixed parts. When the operations on each case have been completed it is attached to a passing magnetic holder projecting down from an overhead conveyor system. This conveyor can be seen on the left in the illustration with cases suspended on its magnetic holders, which, as they descend, are immersed in a degreasing tank. Beyond this tank the conveyor turns back over a transfer station, where the cases are removed and placed on holders for the spray painting operation. The painting holders are in the form of pillars supported on disc bases and they are carried on a steel band conveyor along the length of the transfer station.

At the end of the band conveyor—see Fig. 2—the holders are ploughed off by guide bars on to inclined rails down which they gravitate into one of two paint spraying booths. At the entry side of the booth the holders are picked up on an annular rotating table, which carries them round the circumference of the spraying chamber past two spray heads. As the holders move round on the rotating table their bases register against a belt below the table. This belt provides a friction drive to rotate the holders and thus the clock cases as they pass the paint sprays. As the holders emerge from the spray booth they gravitate on to a second steel conveyor belt, which carries them first through an atmospheric flash-off tunnel and then through an infra-red stoving tunnel. The cases are then removed from the holders and hung on to the pendants of an overhead conveyor leading to the assembly department. This overhead conveyor carries sufficient cases to provide a buffer stock for the assembly lines which enables them to carry on working when it is necessary to change over the spraying section for operation with different types of cases or colours. Each hanger of the conveyor consists of three tiers, each holding two cases. When a change-over is necessary the old colours are still going round on one tier while the new colours are taking their place on another tier. There are always some over of the old colours to enable gaps to be filled in as it is, of course, impossible to completely synchronise the change-over with all the different components involved. A complete change-over of holder heads to accommodate a different clock case and change of paint colour can be made in half an hour.

Adjacent to the case making section is a large mechanised polishing and plating department, and there is also a large water-wash spray booth for painting parts of irregular form. In this second spray booth the parts are placed on basket heads carried along past manually operated spray guns on a moving belt. After spraying the parts travel through a flash-off tunnel and infra-red stoving tunnel.

At the return end of the overhead case conveyor in the assembly section the cases are unloaded and after one operation has been performed on them they are placed on a belt conveyor. This belt conveyor travels along a line of small presses on which the bases, handles, feet, alarm stop spindles, &c., are fitted to the cases. When complete the cases are inspected and hung on to another overhead conveyor which carries them forward to the point in the main assembly line where the movement is fitted into the case. This second overhead conveyor, like the previous one, is used to hold a buffer stock, and any cases not immediately needed continue to circulate on it until required.

The main clock assembly section consists of a large area surrounded by the assembly line. All sub-assembly is carried out in the central area, the sub-assemblies being fed into the main line at appropriate stations either in boxes or by means of overhead conveyors. A number of particularly interesting machines have been developed for the automatic sub-assembly of components, and some of them can been in the photographs we reproduce.

A majority of the wheels in a clock which have a pinion, a spindle or a bush attached are sub-assembled at high speed on specially developed hopper-fed machines. As most of these spindles, pinions or bushes have to be inserted into the wheel at one particular end means have been designed to select the required end automatically and eliminate the need for selective hand feeding of parts.

From a group of these machines we have chosen that illustrated in Fig. 4 for detailed description as typical of the others. This machine is used for the assembly of the large brass centre wheel with its steel centre pinion. The pinion has a plain face at one end, and an annular spigot at the other end has to be pressed into a bore in the centre wheel and fixed.

On this machine, which is air operated through sequence control valves, the pinions are loaded into the funnel-shaped overhead hopper *A*. The centre wheels are loaded in the inclined chute *B*

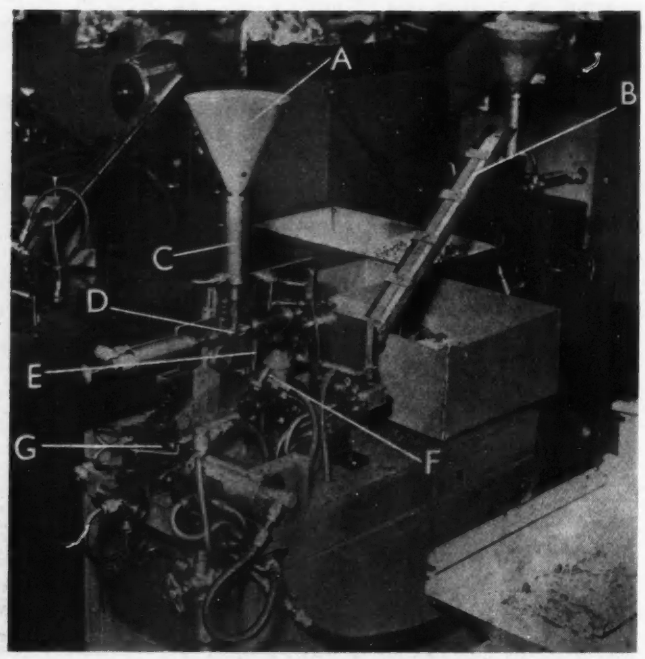



Fig. 4—Automatic hopper-fed assembly machine for fixing centre wheels to their pinions

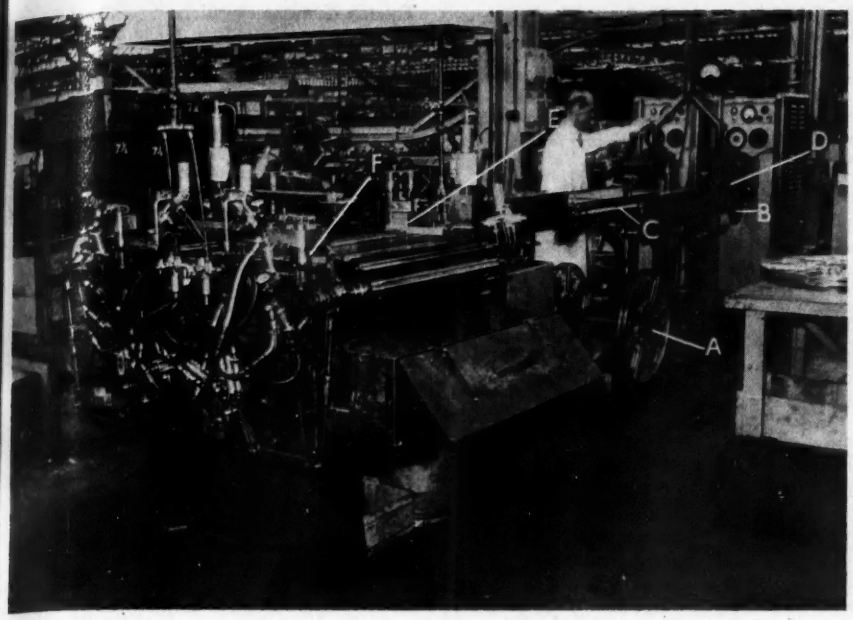



**Fig. 5—Duplex machine for making main and alarm springs from coiled strip**

on the right of the machine. In the sequence of operations the wheels gravitate down the chute to a stop plate and a slide carries them one at a time across to the front of a back-pressure plate at the pinion insertion station.

The pinions gravitate down a feed tube *C* and fall, one at a time, into the bore of a cross feed ram *D*, which carries them across to a feed tube *E* leading down to an indexing magazine *F*. This magazine holds a number of pinions in its bushes, and between indexing operations the pinion in the lowest bush is pushed from the bush through a guide tube into the wheel in the insertion station. The ram which carries the pinion forwards is actuated by an air-operated toggle mechanism *G*. This mechanism at the end of its stroke imparts sufficient pressure on the brass wheel to force it back on an annular riveting punch on the back-pressure plate. This punch slightly distorts the brass round the hole to grip the pinion firmly.

As there is no means to predetermine whether the plain or the spigoted end of the pinion leads when the pinion drops down the hopper feed chute, a turning mechanism has been introduced in the cross feed ram assembly to ensure that the spigoted end always leads when the pinion drops down the indexing magazine feed tube. When the pinion falls from the hopper it drops into a hole in the feed ram and if the spigot is at the bottom it registers in a recess at the bottom of the hole. The top of the pinion is then below the level of the top of the hole and the ram moves forward freely to deposit it in the magazine feed tube. If, however, the spigot is uppermost the plain end of the pinion is too large to drop into the recess and the spigot projects above the surface of the ram. As the ram then moves forward the spigot contacts the face of a scroll sleeve and the sloping scroll face turns the advancing ram so that the spigot faces downwards when the pinion registers over the feed tube. When the pinion drops the ram is returned to its receiving position ready for the next pinion on the return stroke.

In other machines, where parts such as the spigot in the above case cannot be used as a means of selecting the required leading end, a knife-edge balance is used to turn the spindle or other part to face the required direction. All of these machines are air operated and work unattended except for hopper replenishment. Should any operation be incomplete, a part jam up, or a hopper become empty, the machine automatically stops.

Another of this group of machines is that for the assembly of centre wheels on to their spindles, shown in Fig. 3. All operations for this machine are performed by pneumatic rams through the automatic sequence operation of control valves. The assembly consists of a long spindle on which are mounted two washers, a centre wheel with its pinion attached, a tension spring and a collar. The machine has an indexing table and is arranged with two loading stations. The operator at each loading station works double-handed loading parts into two holder bushes in the indexing table at the same time. A spindle is first set in the bush and has placed on it in turn a washer, the wheel and pinion, the second washer and then the tension spring. The table is turned between loading operations to bring the assemblies first below a feed hopper, which drops a brass retaining collar on top of the spring. At the next indexing station an air-operated ram descends to press the collar down the correct distance to load the spring. Three indentation tools are then pressed into the side of the collar to hold it firmly in place on the spindle. These indentation tools are actuated by the turning of a lever-operated scroll cam when the ram has completed its compression stroke. The completed assemblies are ejected by a pneumatic ram at the next station.

All the main springs and alarm springs are made on the machine illustrated in Figs. 5 and 6. On this duplex machine the mainsprings are made on one side, whilst the alarm springs are made in precisely the same way on the other side. The springs are made from tempered steel coil, which has to pass rigorous tests for hardness and ductility before use. The coil of steel is mounted on a spindle *A* to be seen at the side of the machine near the back in Fig. 5 and is fed up round a guide roller *B* at the rear end of the table. The material is gripped by a feed finger operated by an air ram *C* on the side of the machine, and in the first of the sequence of operations this ram draws forward, on each stroke, a full spring length. At the end of this feed movement the rear end of the spring is enclosed in an induction heating coil within the casing *D* and the current is switched on for one second to heat and anneal a length of about 3in of spring.

During the annealing period the feed finger is retracted and again grips the spring to feed it forwards so that a softened length registers between the dies and punches of a pneumatic press *E* at the end of the feed table. There are two sets of tools in this press. One set of tools punches the anchor hole in the spring and the second set simultaneously crops it to length. As the spring is fed forwards initially it registers in a guide channel across the table of the machine. This channel guides the softened end from which the previous spring has been cropped into a forming tool *F* at the far end of the table. Whilst the punching and cropping operation is performed at one end of the length of spring its opposite end, in the forming tool, is bent over to form the hook used to anchor the outer end of the spring to the pillar in the clock movement. It will be seen that the guide channels are mounted on a chain conveyor table, and at the conclusion of each spring punching, forming and cropping operation the spring falls into its channel. The table then indexes to remove the length of spring and to bring the next channel into position ready for the next cycle of operations. In the channel indexing stations adjoining the spring making stations the annealed ends of the spring are sprayed with oil. The control valves of the cylinders at the two ends of the main table are operated in unison by a master cam shaft *G* in the base. On this duplex machine a main spring and an alarm spring are produced every 1·9 seconds.

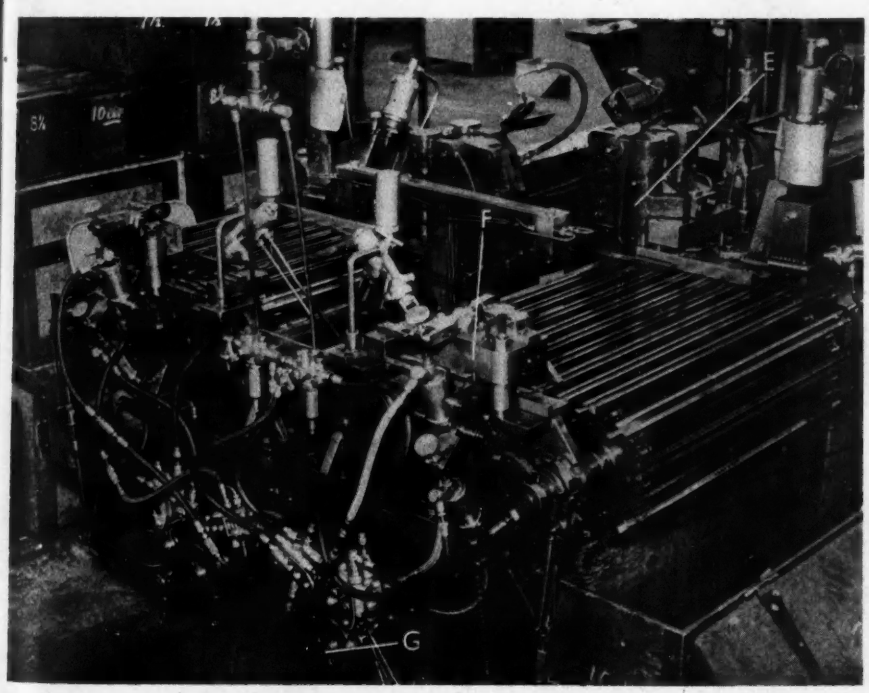



**Fig. 6—Guide-channel conveyor table of spring making machine with air-cylinder-operated cropping, piercing, and forming tools at each side**

*(To be concluded)*

# Open-Side Plano-Milling Machine

*An open-side plano-milling machine weighing some 200 tons has been designed and built by Kendall and Gent, Ltd., for the Dominion Bridge Company of Canada. The machine has a table with a working surface 45ft long by 7ft wide to take work weighing up to 40 tons. It has two 3½in spindle vertical milling heads and a 3½in spindle horizontal head.*

AN open-side plano-miller, believed to be the largest machine of its kind, has been designed and built by Kendall and Gent, Ltd., Gorton, Manchester, and installed in the Lachine works of the Dominion Bridge Company of Canada. The size of this machine, which weighs some 200 tons, can be appreciated from the photographs we reproduce on this page. Its 50ft long, 7ft wide table has a working surface 45ft long and work up to 6ft 6in high can be admitted under vertical face cutters on the two machining heads on the cross arm.

In designing an open side machine of this size the designers were faced with particular problems owing to the fact that the cross slide of cantilever construction spanning a 7ft. wide table had to carry two vertical milling heads each weighing 3 tons. Such a problem had not previously been encountered and it was not known what errors in deflection in both horizontal and vertical planes would result. It was, of course, essential that machine tool limits should be maintained and that the left-hand or outer vertical head be capable of absorbing full power at extreme traverse whilst at the same time producing a flat surface within the prescribed limits.

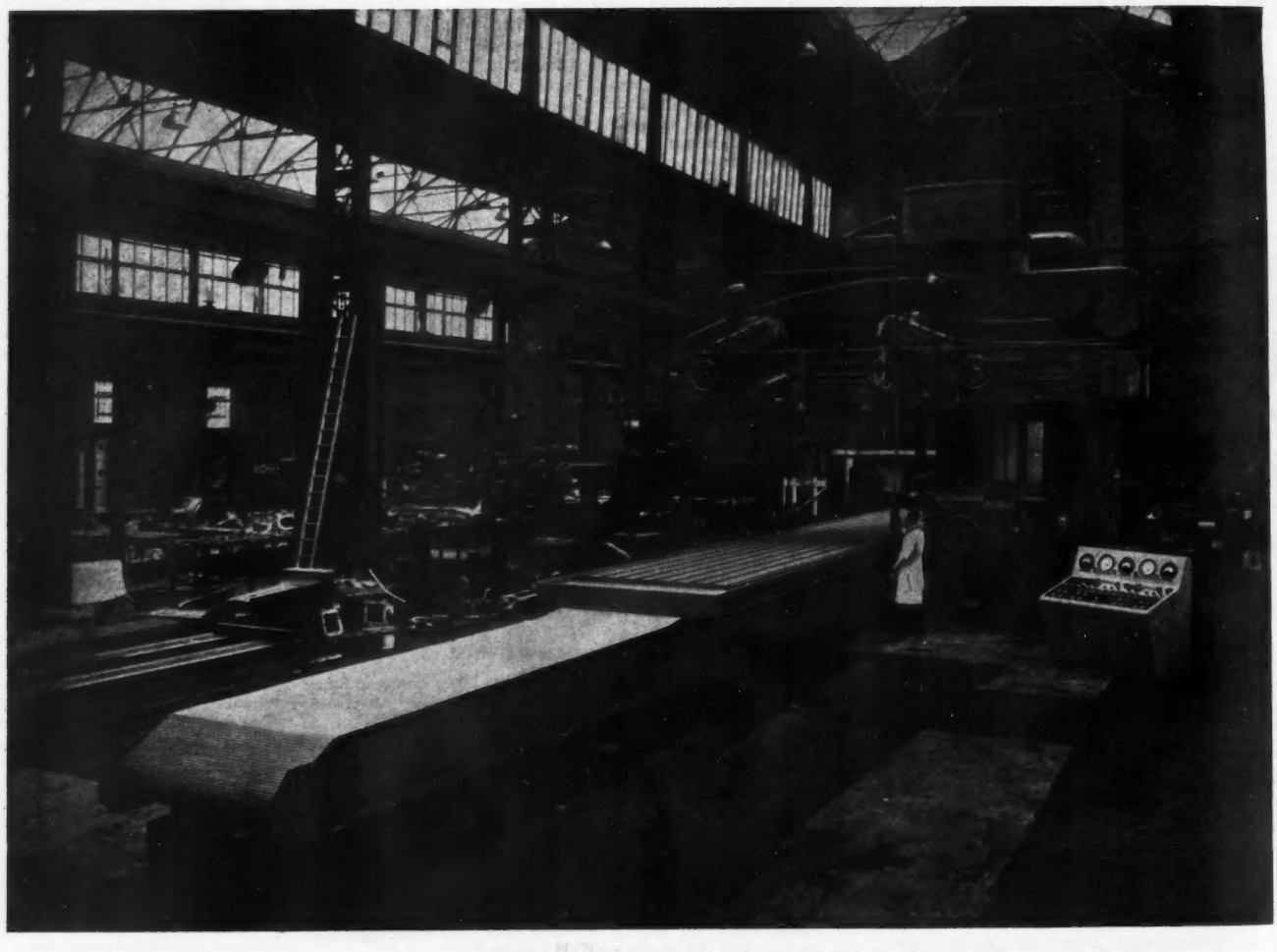
The column, which called for a casting weighing 46 tons, is 19ft 6in high and has a base 11ft 3in by 10ft. It is provided with four main slideways. The first of these slides at the front of the column forms the narrow guide for the horizontal milling head. The cross slide fits across the front slide and the "fish back" support bears against the side slide towards the rear. The narrow guide is provided by the near side of the first front slide and the rear side of the second front slide. It is of interest to note that the total slide area in contact between the column and the cross beam is some 30 square feet. Hardened "Nitralloy" steel plates flush mounted into the column at the side of the front slide provide the main thrust face against which the whole of the cantilever thrust force is taken. The makers state that this use of hardened steel inserted guides has proved particularly successful in providing permanent accuracy of traverse in another large machine of this type which has been in continuous service for four years.

The bed of the machine has an overall length of 84ft and it is made in three sections. The centre section which is 30ft long, and weighs 18 tons, has a 24ft front extension weighing some 10 tons and a rear extension 30ft long, weighing 12 tons. Its slideways are hardened and carry a 49ft long, 7ft wide table, which was made in two sections, each weighing 17 tons. This table is designed to carry a maximum load of 40 tons. Thus the combined weight of a 40-ton workpiece and the table is 74 tons, and when this weight is evenly distributed over the whole of the mating slides the pressure imposed is 12 lb per square inch. Both of the slideways are lubricated by a pump which delivers filtered oil to the interfaces and spring-loaded wooden rollers set in reservoirs at each end of the bed supplement the pumped supply of oil.

The cross slide carrying the two vertical milling heads has an overall length of 25ft and is 6ft deep. When it is fully erected and fitted with the milling heads it has a total weight of 30 tons. The 6in diameter elevating screw for this cross slide is so positioned that it is in alignment with the centre of gravity of the whole mass, and a compensating weight in the form of solid cast iron cores is arranged in the right-hand end of the cross slide casting. The cross slide is elevated by a 25 h.p. motor at a speed of 18in per minute, and a rack and pinion device is incorporated to eliminate any possibility of stagger when it is being elevated. A small electric motor actuating a worm and wheel screw device is used to lock the cross slide in position for cutting. Electrical interlocks prevent operation of the elevating motor when the slide is in the locked condition. A central manually operated "one-shot" lubricating system is fitted to lubricate all the slides, bearings and the elevating screw of the cross arm.

Each of the two vertical and the single horizontal milling heads is of the firm's standard 3½in spindle design. Each head is independently driven by a 25 h.p. motor and has sixteen spindle speeds from 16 to 300 r.p.m. The two vertical heads are arranged to swivel to 30 deg. either side of centre, and the spindle of the left-hand head is equipped with a boring feed of 100 cuts per inch. The non-swivelling horizontal milling head, to be seen in one of the illustrations, is fitted with a separate motor-driven boring and drilling traverse having six feed rates from ½in to 2in per minute. The left-hand vertical spindle is adjustable along the cross slide up to a maximum distance of 9ft from the upright, and the right-hand vertical spindle can be set up to 5ft from the upright. The vertical spindle sleeves have a micro adjustment of 12in and the horizontal spindle sleeve an adjustment of 18in.

The traverse drives to the table and the milling heads are electronically controlled to enable variation of the feed rates by alteration of the driving motor speeds. The final drive to the table is through the maker's design of segmental rack mechanism. With this mechanism the load imparted by the drive is distributed over every

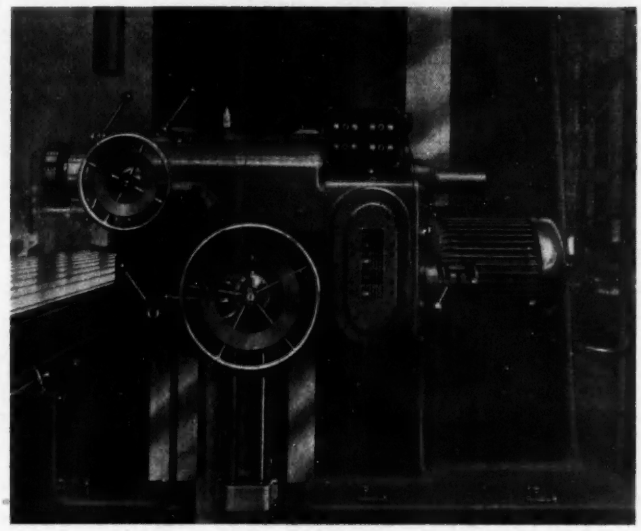


**Open-side plano-milling machine with a 50ft long by 7ft wide table, to take work weighing up to 40 tons. All motions are driven by individual motors electronically controlled**

tooth in the final worm and each tooth engages across the full width of the rack. The special design of electronic Ward-Leonard equipment used for the transverse drive of the table and milling heads provides a preset rapid traverse and a steplessly variable feed traverse.

The performance called for in both the table and milling head traverse drives is similar, a very wide range of driving motor speeds, together with accuracy of speed regulation against load, being required. The speed-setting accuracy has also to be of a high order, and particularly in the case of the table drive, a rapid deceleration is required in order to stop the table in the shortest possible distance.

The basic arrangements are similar for both the table and milling head traverse drives; each utilises a d.c. driving motor fed from a generator forming part of a three-machine motor generator set, driven by an a.c. motor. In each case the output voltage of the d.c. generator, and hence the armature voltage of the d.c. driving motor, is controlled by means of a single-phase full-wave thyratron rectifier feeding the generator field. In addition, to meet the requirement for a very wide speed range called for, the excitation of each of the motor fields is also controlled, again by a single-phase full-wave thyratron rectifier arrangement.



**3½in spindle horizontal side milling head with boring and drilling traverse**

To provide good speed regulation each generator and motor forms part of a closed-loop, speed servo system. The speed of the motor is measured by a special tachometer generator (to which further reference will be made later), and the output voltage of this tachometer generator is compared, in a subtractive sense, with a highly stable reference voltage derived electronically within the control equipment. If the speed is incorrect, an error signal will appear at the output from the comparison circuit: its magnitude will depend upon the amount of speed error and its polarity will indicate whether the motor is running fast or slow. The error signal is amplified and used to control the thyratron rectifiers so as to minimise the error, i.e. if the motor is running fast the thyratron rectifier output will be reduced and so decrease the generator field excitation and vice versa. The speed of the motor is set to the desired value by adjusting the reference voltage, as determined by the speed setting knob on the control desk.

The thyratron rectifier feeding the motor field normally fully excites the field, but when a speed above that for full armature voltage and full field is required the output of the thyratron rectifier is reduced and the field weakened, to increase the speed of the motor. In the case of the table drive, speeds for normal operation are 1½in to 24in per minute, being increased to 150in per minute for rapid traverse. The corresponding motor shaft speeds are 30 to 480 r.p.m. for normal operation and 2300 r.p.m. for rapid traverse, a speed range of 76 : 1. The Lancashire Dynamo d.c. driving motor, which has been specially designed for this duty, has a basic speed, at full armature voltage and full field, of 1000 r.p.m., being capable of delivering 45 b.h.p. at this speed. For normal operation, however, as already pointed out above, a range over armature control from 30 to 480 r.p.m. is used. The high speed for rapid traverse is therefore obtained by increasing the armature voltage to maximum and weakening the field to provide an output speed of 2600 r.p.m., the rating at this speed being 20 b.h.p. This compares with a rating of 25 b.h.p. at the maximum speed for normal operation of 480 r.p.m. To provide satisfactory operation for long periods at low speeds the motor is force-cooled, a separately driven integrally mounted fan unit providing continuous forced ventilation of the motor.

Over the working speed range from 30 to 480 r.p.m. the speed regulation is better than ±1 per cent for zero to full load, the long-term stability being of a similar order. The provision of a tachometer generator to operate in this speed range from 30 to 480 r.p.m. and to operate at 2300 r.p.m. proved to be very difficult, normal permanent magnet generators being unsuitable for reasons associated with the wide difference between output voltage at the normal running speed and the rapid traverse speed. A special tachometer generator with a wound field was therefore developed for the application, the field being fed from an electronically stabilised constant current supply. By controlling the current, depending upon the conditions called for, the output voltage under overspeed conditions is limited and a reasonable voltage for control purposes can be obtained under normal running conditions.

In addition to the speed control servo system outlined above, the thyratron rectifiers feeding the generator field are also controlled to provide automatic current limitation on the driving motor so that the torque delivered by this motor is limited. This control is achieved by obtaining a signal from the motor armature circuit which is proportional to the current flowing in the armature. When this signal, and hence the current, reaches a predetermined level, the speed control system is overridden and the output of the thyratron rectifier reduced. The current is therefore limited to the preset value even if the motor is stalled. This control arrangement results in the current being limited during the run-up period so that acceleration takes place under constant current conditions. Because of the special rating of the motor, the current under overspeed conditions has to be held to a value below that for normal running and the circuits are arranged so that the current limiting level is automatically reduced when overspeed conditions are selected.

The current limiting circuits also come into play during braking, when use is made of the inherent regeneration characteristic of the electronic Ward-Leonard system. If the drive has to be stopped or a reduction of speed called for, the generator field excitation is accordingly reduced. The power from the mechanically stored energy in the system then drives the d.c. motor as a generator and this in turn feeds power to the d.c. generator, which, acting as a motor, feeds the power back into the supply system through the a.c. motor. This technique provides very rapid braking and the motor can be stopped from a full, rapid-traverse speed condition, in some forty revolutions, and the table can thus be halted from the rapid traverse speed of 150in per minute in about 2in of travel.

The arrangements for the milling head traverse motor are similar to those for the table drive, except that the speed range (100 : 1) is somewhat wider. The normal traverse speeds are from 30 to 1440 r.p.m. of the motor, corresponding to ¼in to 24in per minute. The base speed of the motor is 1440 r.p.m. and the rapid traverse at 3000 r.p.m., corresponding to 50in per minute, is obtained by motor field weakening. The powers available are 10 b.h.p. at 1440 r.p.m. and 10 b.h.p. at 3000 r.p.m.

In addition to the basic control systems which have been outlined for each motor, an additional control refinement has been introduced by which the table or milling-head traverse speeds are controlled by the load on the milling cutter a.c. drive motor, should this exceed a preset value, as could occur if the operator set too high a rate of feed for a given depth of cut. In operation, if the milling cutter a.c. drive motor load reaches the predetermined limit, the table or milling head traverse speed will be automatically reduced to prevent the load on the milling cutter motor speed rising further. No damage will be done to tool, work or machine and the speed reduction will become apparent to the operator, who can then make the necessary adjustments.

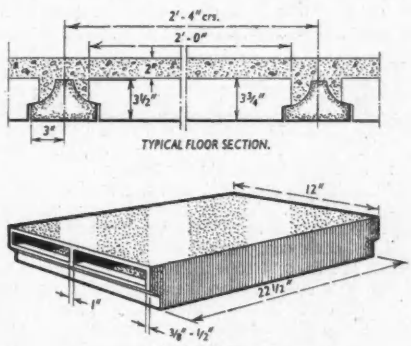
Since the driving motor and generator fields are fed from the a.c. supply through the controlled thyratron rectifiers, a further protective device has been included to prevent table overrun in the event of supply failure. If the supply fails, the system automatically becomes self-exciting, dynamic braking being applied to the driving motors, the motor generator set continuing to rotate, by virtue of its stored energy, for a time well in excess of that required to stop the table.

All controls for the machine are carried on the control desk and a pendant is fitted carrying only traverse buttons so that the operator has at hand on the pendant all the controls required after selection of the milling heads from the control desk. In addition to the push buttons, the desk carries ammeters and reversing switches for the spindle motors potentiometers for the variable-speed motors and large tachometer dials on which the actual feed traverse set by the potentiometers is registered.

To assist operation and access to the machine for servicing a platform is fitted across the front of the cross slide; it enables adjustment to be made at the milling heads without climbing over large workpieces. A ladder fitted at the rear allows access to the fish back at the rear of the cross slide for easy withdrawal of the draw bolts on both vertical spindles.

## Lightweight Floor Structure

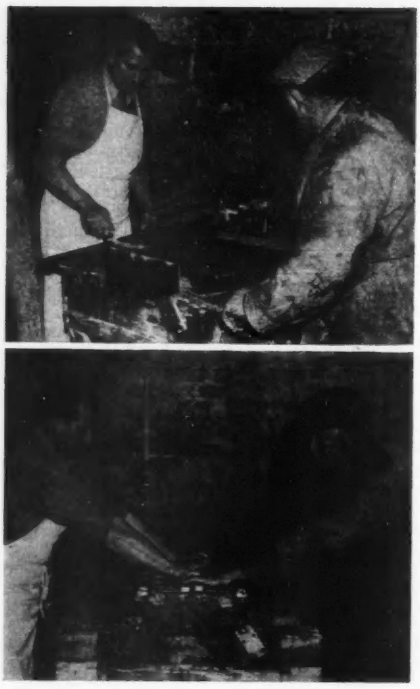
IN THE ENGINEER of November 14, 1952, we described the construction of a yeast factory near Harwich; the description included details of a floor and roof system using Shishkoff cast hollow units. These units have now been employed in rather a different way, to form a floor or roof slab of light weight. A recent example of their use is that of a garage extension




10ft span beams: steel, six 0·2in diameter indented H.T. wire ult. stress >100 tons per square inch; 1 per cent proof stress >80 tons per square inch; release stress 64 tons per square inch; working stress 54·4 tons per square inch.
Concrete: Aluminous cement, sharp sand and shingle to give minimum strength of 6600 lb per square inch at twenty-four hours, i.e. release 9000 lb per square inch at twenty-eight days.
Hollow blocks: 12in by 24in by 4in. Volume ⅓ cubic foot; weight 32 lb; concrete, 3 : 1 sand; cement mortar, minimum strength 5000 lb per square inch.

**Details of floor structure and hollow block**

at Richmond, where it was decided to add a first floor over an existing single-storey garage of 2700 square feet, to double the accommodation for cars. A steel frame, separate from the existing building frame, which already had sufficient headroom, was therefore erected, with stanchions up to the first-floor level, and steel beams spanning the proposed first-floor at 10ft centres. A prestressed concrete ramp was built at a slope of 1 in 9, to give access to the first floor. This ramp spans 50ft ; it is 9ft 4in wide and 7in deep, with wing walls 8in wide and 12in high at each side, which were built monolithically with the main slab and are thus part of the load-bearing structure. The ramp was post-tensioned with six Freyssinet cables, each with twelve 0·276in diameter wires. It was built on centering carried on



**Stages in casting a hollow floor block. Brown paper is first laid on the mould and covered with a layer of mortar (top). Then two pairs of folding wedges are placed in position and the mould closed (bottom)**

adjustable steel props, which allowed part of the space under the ramp (where there were petrol pumps) to be utilised during construction. The ramp is situated at the side of a narrow access way and illustrates the advantage of using prestressed concrete in a confined site, both by virtue of the narrow construction depth and the comparative lack of congestion (concrete was brought to the site ready mixed) when it was built.

The construction of the garage floor is shown in the accompanying diagram. Light prestressed concrete beams span the 10ft lengths between the beams of the primary steel structure and the hollow units rest, side by side, on these beams. The floor is completed by a layer of light mesh reinforcement and a screed of concrete 2in thick. The completed floor weighs 42½ lb per square foot ; the weights per square yard, of each component, are : beams 56 lb, blocks 116 lb, and screed 210 lb. The strength of the floor conforms to the by-law loading for light cars of 80 lb per square foot. Floor construction of this kind is adequate for spans up to about 14ft or 15ft, but for spans above 10ft extra pretensioning wires are included in the beams and a prop is placed at mid-span until the screed has matured. For lighter loads, such as floors of houses, the wire mesh can be omitted and the screed thickness reduced. For spans up to 30ft and for greater loading the system envisages deeper beams and correspondingly larger hollow blocks, such blocks will weigh about 30 lb per cubic foot, it is estimated.

Casting of the hollow blocks is illustrated in the two photographs reproduced herewith. A hinged steel mould is used and perforated brown paper is first laid on it, followed by a ¼in layer of mortar. This stage is shown in the upper illustration. Two pairs of folding wedges, which form the hollow spaces in the block, are then placed in position, and each side of the mould is rapidly placed over them, as shown in the lower illustration. The hinged side pieces can be folded back immediately, as the paper holds the mortar in position and after filling the centre section, between the pairs of wedges, with mortar, the mould is removed from the bench and stacked against adjacent moulds, to give some side support during setting. The hinged side sections remain on the bench for casting the next unit.

The casting of a block takes two men four to five minutes, it has been found, and subsequently demoulding requires two men from two to three minutes and oiling and cleaning the core two to three minutes for one man, i.e. fifteen to twenty man-minutes per block. Demoulding is the operation requiring time and care and so an improvement is to be introduced whereby the block will not have the central rib and the hollow space will be formed by a core of expanded metal or other suitable material which will remain inside the block permanently. Thus, the amount of labour will be reduced by about half, offsetting the cost of the metal core. The mortar strength and other data for the blocks are given in the legend with the first illustration.

The work as described in this article was carried out under the direction of Mr. Paul Shishkoff ; the contractor was W. Jenner, Ltd. The steel structure was erected by Dorman, Long and Co., Ltd., and the precast pretensioned beams of the floor system were supplied by Pierheads, Ltd.

# A.C. Winder with Dynamic Braking and Speed Control

*Here we describe a new system of dynamic braking and speed control as applied to the recently commissioned a.c. winder at Avon Colliery in South Wales. The winder is operated by a 1100 h.p. slipring motor which, with its control gear, is designed to raise about 3 tons of coal per wind, forty-seven winds per hour, from a depth of 1575ft.*

AN a.c. winder with dynamic braking and speed control has recently been commissioned at Avon Colliery, Blaengwynfi, South Wales, to replace the previously existing steam engine. The new drive which was made and installed by The General Electric Company, Ltd., consists of a 1100 h.p., 3·3kV, 475 r.p.m. slipring induction motor with its associated control gear and a new parallel winder drum, 12ft diameter by 8ft wide ; the drum was built at the company's Erith works.

The depth of wind is 1575ft and the plant is designed to raise approximately 3 tons of coal or 5½ tons of stone per wind. Briefly, the winding cycle is as follows : acceleration, ten seconds ; full speed, 36·3 seconds ; deceleration, ten seconds ; decking, twenty seconds.

This duty represents about forty-seven winds per hour, giving an hourly output of some 140 tons of coal.

This installation, which is illustrated here, is the first a.c. winder in Great Britain to use the new G.E.C. system of dynamic braking and speed control, the operation of which, as far as the driver is concerned, approaches closely that for d.c. equipments using Ward-Leonard control with over-riding current limitation. Another point of interest is that the complete changeover from steam to electric winding was effected during the annual fortnight's holiday.

The control system is a further development of a similar scheme installed for four 4200 h.p. a.c. winders in the Orange Free State Goldfields, the first two of which were commissioned some three years ago. They were designed to give accurate torque control. With the additional facility of speed control, as embodied in the Avon colliery installation, a direct relationship is established between the steady rope speed and the position of the driver's lever.

Referring to the accompanying diagram, it can be seen that automatic variation of the rotor circuit resistance of the winder motor is effected through the medium of an oil servo mechanism, the operating valve of which is governed by two control coils, acting in opposition to each other. Coil *LR*, which causes the resistance in the rotor circuit to be reduced, is energised by alternating current. When driving, this current varies with the speed error. During dynamic braking, this current is constant.

The other coil, *RR*, which serves to insert resistance, is excited from the stator winding of a control generator, *CG*, driven from the winder motor. At any given rotor (or primary) excitation of the control generator, the voltage across this coil reflects that of the rotor of the main winder motor and varies in proportion to the slip or speed. The actual proportion is dependent upon the speed error.

The main characteristics of the system can be appreciated from the diagram by considering the sequence of events resulting from three typical quick motions of the driver's lever.

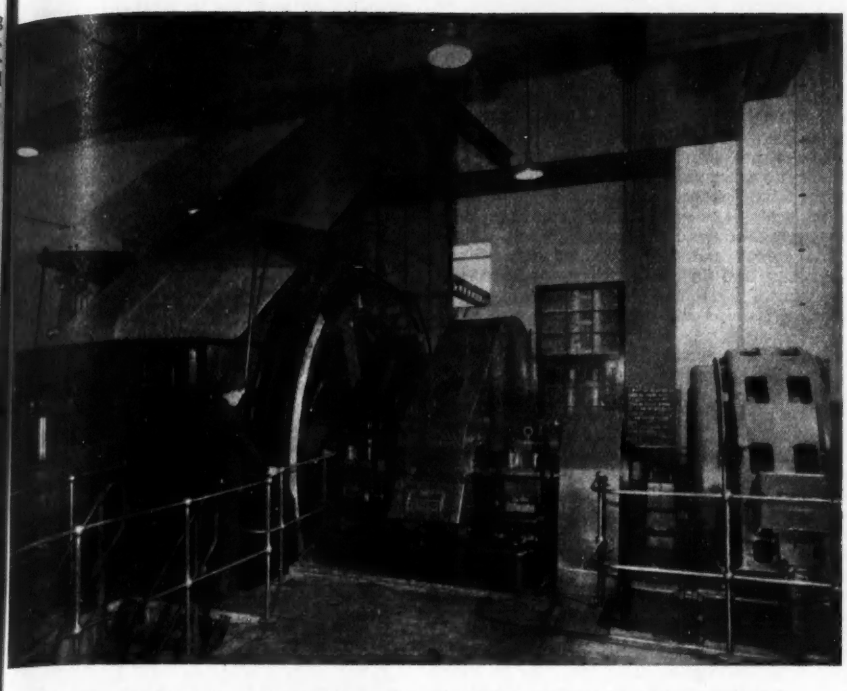
"*Stop*" *to* "*Half-Speed Forward.*"—Movement of the driver's lever through the gate immediately sets up control circuits for the "Forward" direction. Further movement to the half-speed forward position causes the pattern potentiometer *PP* to apply half of its maximum voltage to the speed error signalling loop *TG-MA*1-*PR* circuit. The current saturates the amplifier *MA*1 which produces its maximum output. At the same time the polarised relay *PR* closes contacts which set up the main contactor circuits for "driving."

With any speed error in excess of a predetermined value the magnetic amplifier *MA*1 delivers its maximum output to the control windings of the biased saturable reactors *SR*1 and *SR*2 via the forward or reverse contactors *F* and *R*. As the control winding opposes the bias winding of *SR*1 this reactor then gives minimum output and hence minimum excitation of the control generator *CG*. The excitation and consequently the pull of coil *RR* is, therefore, at its minimum.

But as the control winding assists the bias winding of the saturable reactor *SR*2, the output from this reactor produces maximum excitation of the coil *LR* of the oil servo mechanism. Thus the pull of coil *LR* is able to overcome that of coil *RR* and reduce the resistance of *R*1 and of the liquid controller *R* to the required values for the winder motor *WM* to accelerate at the chosen maximum torque. As the motor gathers speed the tacho-generator voltage rises. Since this voltage opposes the pattern voltage, the current in the speed-balancing winding of the amplifier *MA*1 falls ; no change takes place, however, in the output from this amplifier because it is so designed that it remains saturated so long as the difference between the tacho-generator voltage and the pattern voltage is large.

Acceleration continues, therefore, at maximum torque until the actual speed approaches the selected speed, when the output of the amplifier *MA*1 falls. This fall results in a rapid rise in the output voltage of the biased saturable reactor *SR*1 and, thereby, causes the excitation of *CG* to increase. Accordingly, coil *RR* takes control and raises the resistance of *R*1 and *R* until the torque of the winder motor equals the load torque ; consequently the speed no longer increases.

As the wind proceeds, the down-going load



**1100 h.p. geared winder at Avon colliery. Dynamic braking and speed control are embodied**

increases with the length of rope and may ultimately exceed the up-going load. In this event the speed will rise : when it exceeds that set by the driver's lever, the tacho-generator voltage will exceed the voltage derived from *PP* and the current in the speed balancing winding of *MA*1 and in *PR* will be reversed. The reversal of current in the speed balancing winding has no effect, because the amplifier *MA*1 is non-directional and gives the same output for the given control current in either direction. The polarised relay *PR*, however, changes over its contacts, thus causing the main driving contactors to open and the main braking contactors to close.

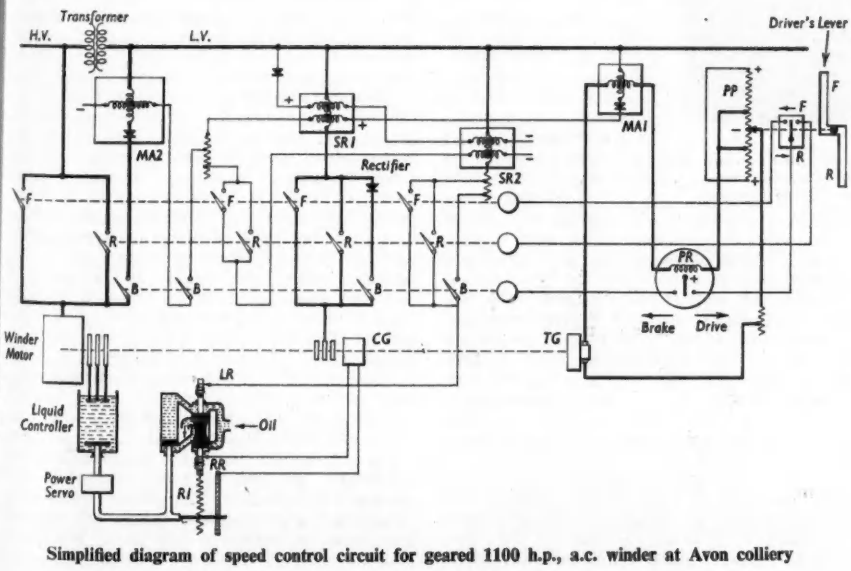
As a result, the output from the amplifier *MA*1 feeds the saturable reactor *SR*1 and the magnetic amplifier *MA*2, while *SR*2 receives constant excitation. An increasing d.c. excitation is supplied by the magnetic amplifier *MA*2 to the stator of the winder motor *WM* until the braking effort is sufficient to balance the down-going load. During dynamic braking the reactor *SR*1 supplies d.c. excitation through the rectifier *REC* to the control generator *CG*. The relationship between the excitation of the winder motor and that of the control generator is so chosen that the resistance *R* is automatically kept at its optimum value, independently of the motor speed.

On entering the retarding zone, the driver moves back the lever to reduce speed. The tacho-generator voltage then exceeds the " pattern " voltage and braking excitation (limited by the amplifier characteristics) is applied. Maximum braking torque is developed by any rapid backward movement of the driver's lever. On reaching bank, full application of the mechanical brakes opens the dynamic braking contactor.

*" Stop " to " Full Speed Forward " and Regenerative Braking.*—Acceleration to full speed takes place at maximum torque, as already described. Assuming that the wind is such that regenerative braking is possible, this will begin on a slight rise in speed above synchronism, the pattern potentiometer *PP* being set to permit the necessary increase without changing over to dynamic braking.

On entering the retarding zone a backward movement of the driver's lever will cause the polarised relay *PR* to change over and initiate dynamic braking.

*" Full Speed Forward " to " Full Speed Reverse " (Reverse-Current Braking or Plugging).*—The first movement of the driver's lever from " forward " towards " stop " will, of course, initiate dynamic braking, since the " pattern " speed will be less than the actual speed. When the lever passes through " stop " towards " reverse," the " pattern " voltage increases once more in the same direction, but as the field of the tacho-generator *TG* is reversed the " pattern " and tacho-generator voltages are now additive. The polarised relay *PR*, therefore, restores the " driving " circuits, and reverse-current braking is applied at maximum torque and under optimum conditions.




**Simplified diagram of speed control circuit for geared 1100 h.p., a.c. winder at Avon colliery**

## Industry-Based " Sandwich-Scheme " for Professional Training of Engineers

A DIRECT approach to the professional training of engineers has been made by The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, with the announcement that the company has introduced a new form of " sandwich course." The purpose of the new scheme is the recruitment and training of boys leaving public schools and grammar schools, to become professional engineers capable of filling responsible engineering, administrative and sales positions in industry. This object is to be achieved by an industry-based five-year sandwich course operated by the company in conjunction with the Birmingham College of Technology. It will be appreciated that this scheme is intended to augment rather than to replace the traditional channel of supply of professional engineers—three years at a university, followed by two years of graduate apprenticeship. Nevertheless, the intention is that, at the end of the sandwich course, a young man, at the age of twenty-three, will have gained exemption from the professional requirements of a body such as the Institution of Electrical Engineers and will, if he remains with the G.E.C., have as good prospects in the company as the graduate apprentice.

On leaving school at the age of eighteen boys selected by the company for this method of training are given a five-year course in which full-time six-month sessions at the Birmingham College of Technology alternate with six-month periods of industrial training in the company's works. Appropriately, since the scheme is based on industry, the student starts and ends his course in the works. Training begins with a short induction period which gives an insight into the company's own activities and into the place the company occupies in industry as a whole. The rest of the first six months at the works is devoted to training under instruction in fundamental engineering techniques. Then the student starts the first of four six-month sessions at the College. There his theoretical instruction is on a broad scientific basis ; in the later stages it includes at least one branch of study, selected by the student himself, bringing him to grips with a subject outside technology : history, philosophy, law and languages are typical choices. To enable the young man to enter into the social life of the college the curriculum is deliberately limited to twenty-seven hours a week.

The alternate six-month works periods are allocated partly to classroom instruction and partly to practical training. Periodic reviews and interviews by a special board ensure that the progress of each trainee is closely watched and guided throughout the course. In the later sessions the trainee is given progressively more responsible work until, in the final year, which is spent wholly in the industry, he is given definite tasks of engineering responsibility so that he may complete his course with full confidence in his professional ability.

Throughout the five-year course the company pays a student's college fees and gives him suitable remuneration to cover his living expenses. Two country houses in the Midlands, Castle Bromwich Hall, near Birmingham and Coombe Abbey, near Coventry, are used by the company as halls of residence. All students have a fortnight's paid holiday in the summer during their industrial training. They have their National Service deferred until their course is completed.

At present about sixty G.E.C. student trainees are at the Birmingham College of Technology on the first year of their course.

# Test Table for Thermionic Valves

A VALVE test table designed to facilitate the life testing of thermionic valves, without fatigue to the operator, has been developed by the research staff of the M.O. Valve Company, Ltd., working at the G.E.C. research laboratories, Wembley.

Life test measurements can provide a useful guide towards improvements in valve quality but, because the procedure is expensive, only a small proportion of a production run is tested in this way. Consequently, a single premature failure during the test is highly significant and the measurements have to be made with as little chance of error as possible. This requirement is not met with in normal production testing where large numbers of valves are tested at high speeds and the effect of error, though undesirable, is less important.

The new table, shown in Fig. 1, is designed to comply with four main requirements: first, that it should be suitable for all major tests on any kind of receiving and low-power transmitting valve; secondly, that its accuracy should be stable over a long time; thirdly, that it should be easy to use without fatigue to the operator, and, fourthly, that it should be easy to maintain and modify or extend. Once the main electrical details had been worked out the design and arrangement of controls and instruments were governed primarily by the requirements of the operator and the maintenance engineer, in that order. Experience in the first six months' regular use of the table has, we learn, justified the placing of emphasis on the operator's requirements.

The meters are arranged in a banked semi-circle so that each can be read with equal ease. The controls are all operated by the left hand, leaving the right hand free to record the measurements and select the appropriate test connections.

**Fig. 1—Valve test table. The instruments are arranged in a banked semi-circle, about half of which can be seen in the photograph. The controls are operated by the left hand, leaving the right hand free for recording results or operating the push-button selectors**

The grouping of the controls on the panel has been carefully worked out so that the knobs and keys used in any particular test are adjacent to one another. The general arrangement of the controls conforms with the normal sequence of measurement operations.

Particular attention has been paid to the appearance of the instrument face, bearing in mind that the operator's attention is directed to the instruments for many hours each day. Instruments with finely divided scales, knife-edged pointers and anti-parallax mirrors were rejected because, although they are intrinsically accurate, they often cause considerable visual fatigue in an observer after prolonged use. The instruments used in this test table have a somewhat lower intrinsic accuracy but greater visual clarity.

The objectives of reducing fatigue and maintaining accuracy are achieved, first, by the shape of the table; secondly, by the removal from the meter scale plate of all non-essential markings, including the outer division arc lines and, thirdly, by a colour and brightness balance between scale, case and surround, whereby the pointer—the item of greatest interest—becomes the most prominent object in the field of view.

The instrument units used throughout the test table are 6in and 4in "Bakelite"-cased meters finished in beige. These units are normally supplied to "industrial" accuracy, but for this particular use they were specially calibrated to give "precision" accuracy over the upper half of the scale. All the larger meters are multi-range instruments, the majority having four ranges. By analysing the distribution of voltages and currents to be read when measuring the characteristics of receiving valves, it was possible to choose meter scalings which brought most of the measurements into the upper and most accurate part of the scale range.

The ranges may be changed either manually or automatically. Push buttons placed immediately below each meter are used for selecting the range and relays carry out the switching sequence when automatic range changing is being used. Each meter, with its associated push button, switches and relays, is mounted on a steel plate which fits into one of the square apertures let into the table case. A dust cover at the back of the plate encloses the switch and relays, connection to the main table wiring being effected through a flexible plug and socket cable at the back of the box. This general arrangement results in a meter which is readily removed for servicing (Fig. 2). To eliminate the possibility of error from magnetic effects, all the instruments were calibrated after fitting to the mounting plate.

The range on which a meter is operating is indicated by an illuminated disc seen immediately above the scale marking. Each range indicator consists of a ½in diameter "Perspex" rod, cemented into the case of the meter; a hole in the scale plate registers with the face end of the rod, which is obscured by a strip of white "Cellophane." This refinement renders the indicators less noticeable when not in use. The other end of the "Perspex" rod which projects from the back of the meter case is illuminated by a standard telephone lamp and is engraved with a multiplication factor to suit the required range. The engraved letters are filled with opaque wax and appear dark against an illuminated background when viewed from the front.

Besides the instruments described, the test table incorporates a mirror galvanometer for the measurement of gas current. It is used in the range 5 millimicroamperes to 50 microamperes and is displayed on the horizontal scale immediately before the operator, as illustrated.

The test table is operated from a 230V, 50 c/s regulated mains supply. Power for valve anodes and screen grids is derived from two stabilised power packs which deliver up to 250mA at 350V; these packs, together with other equipment, are housed on two telephone-type racks situated in the rear of the table A third power pack is available; it is unstabilised and has a maximum output of 500mA at 500V. Each of these power packs has a single control enabling the output to be set at any required voltage.

The d.c. heater power unit can supply up to 4A over the voltage range 1V to 80V. Coarse and fine controls of heater voltage are provided. Other supplies include those for grid bias, heater-cathode insulation measurement and for mutual and conversion conductance. The table does not provide facilities for measuring total cathode emission under pulse conditions, nor for measuring cathode core-coating interface resistance, since tests of these kinds cannot readily be combined with those for the more generally used valve parameters.

Connections between the various units are made through a system of fixed cable forms which lead to a double row of tag blocks mounted at the rear of the test table. With a few special exceptions, such as galvanometer leads, all connections between units are carried to the tag blocks, and connected together with jumper wires. This system has proved to be flexible and it enables alterations to the connections to be carried out quickly, without disturbing the permanent wiring.

**Fig. 2—One of the 6in instrument cases being removed for servicing. Above it is the scale of the mirror galvanometer for measuring gas current**

One of the main problems in the design of this multi-purpose test equipment was that of providing a convenient connection field between the various supplies and the pins of the different valves to be tested. Not only have several kinds of valve sockets to be dealt with, but different types of valve using the same socket may have varying electrode connections. Push-button switches were chosen for this test table because they facilitate rearrangement of connections if required. The push-button field is seen at the operator's right hand in Fig. 1.

Most life test samples consist of four valves. For this reason the test table is provided with four valve sockets of each type. Initially, filament and h.t. volts are applied to all four valves through a "warming" circuit to bring them to working temperature. Push-button switches are then used to transfer each valve in turn from the "warming" to the test circuit, while the others continue warming. With this facility testing can be speeded up considerably; once the table has been set up to measure a given parameter, the measurement can be carried out rapidly on all four valves. The warming circuit includes fault protection which indicates the presence of a valve having an inter-electrode short circuit.

The case of the test table was made to G.E.C. design by H. J. Mulliner and Co., Ltd. It is made of sheet steel sections. Removable panels all round the table give easy access to the electrical equipment. The colour finish is a semi-gloss light chocolate colour, the control area being in removable light-grey "Warerite" panels.

# Programme of Road Construction

ON Wednesday, February 2nd, a statement was made in the House of Commons by the Minister of Transport and Civil Aviation, Mr. J. Boyd-Carpenter, about the Government's plans for road construction. We print the statement below and also give the list of new schemes to which the Minister referred.

"I am now in a position to make a statement on the first instalment of the Government's expanded road programme. There have been few major improvements and very little new construction in our road system since 1939, and the problem which now faces us is therefore an immense one. Her Majesty's Government is working to plans which will take a good many years to complete, but which are intended to provide this country with an up-to-date road system. These plans include both entirely new motor roads of the most modern construction and an ordered series of major and minor works on existing through routes, the individual items of which are planned so as, taken together, to convert these routes into modern all-purpose highways. The construction of new roads is a process which takes some time to begin because compliance with the statutory procedure designed for the protection of the interests likely to be affected means that a considerable period must elapse before the line of the road can be finally determined and the necessary land acquired. Consequently the work done in the early years of the programme must necessarily be mainly in connection with the improvement of existing routes.

"Items have been selected for an early place in the programme which in the judgment of Her Majesty's Government are of the greatest urgency for relieving congestion of traffic, particularly industrial traffic, and for promoting road safety. In this selection we have necessarily had regard to such essential preliminary considerations as the state of preparedness of schemes and the availability of land. I propose to circulate (see below) a list of schemes which I hope to authorise during the financial year 1955–56. For trunk roads, for which I am the highway authority, this list includes schemes costing over £100,000 each ; but in view of the need for further consultation with local highway authorities which is proceeding in respect of classified road schemes, I have only included two such schemes, each of which involves an Exchequer contribution of over £500,000. One, the Dartford-Purfleet Tunnel, was in the list announced by my predecessor and the other has been inserted after consultation with the promoting authority. The list does not, as the House will see, include the Hyde Park Boulevard scheme. This is at present under consideration. I should mention another important London scheme which I hope to authorise before the end of this financial year. That is the first instalment of Route 11, to which I referred in my statement on traffic congestion on November 17th last. I am also circulating a list of schemes on trunk and classified roads likely to cost the Exchequer more than £500,000 each, which I hope to authorise during the three years 1956–57, 1957–58 and 1958–59. I have not at present gone below the £500,000 mark in the list for these later years because the final selection of a large number of the many schemes involved requires further consultation with highway authorities and others.

"As regards Scotland, the House will be aware that it is proposed that my Rt. Hon. Friend, the Secretary of State, should take over my responsibility for roads in Scotland as from April 1, 1956. I have therefore been in consultation with my Rt. Hon. Friend in the selection of schemes for Scotland, and I am circulating lists corresponding to those for England and Wales. A number of these schemes are on the main Glasgow-Carlisle Road (A.74), which carries a heavy volume of industrial traffic and which it is hoped progressively to convert into a first-class highway with dual carriageways throughout. We shall, of course, complete the special Highland roads programme which the Secretary of State for Scotland announced on July 14, 1953. In addition it is now proposed to make a substantial increase in the work being done on the Crofter Counties programme, beginning with a commitment of £350,000 in 1955–56 and aiming, in the course of the next three years, at annual commitments of about £750,000. It is also intended to undertake other Highland schemes not at present in any of these programmes. Of these the most important is the Inverness river bridge which it is hoped to commit in 1956–57.

Over and above schemes in particular localities there are certain major projects of national importance which should be ready for commitments towards the end of this period. They will be projects of great magnitude and the cost will be formidable ; indeed, to enable us to proceed as rapidly as we should like the Government have in mind that tolls should be charged in suitable cases. This will enable the Exchequer to get back something on the money put up and will, of course, include provision for sharing between the Exchequer and local authorities where the latter had also put up money.

"The first of these projects will be the first section of a London-Yorkshire motor road ; that is, a road confined to motor traffic with severely restricted access and with fly-over crossings and junctions. The first section will extend from the north end of the proposed St. Albans By-pass to a point near Rugby, with a spur for Birmingham traffic connecting with the existing trunk road A.45 to Birmingham, which road is itself to have dual carriageways and by-passes at Dunchurch and Meriden.

"Following on the first section of the London-Yorkshire motor road the Government would wish to put in hand, not only the remainder of that motor road, but also the north-south motor road through Lancashire from Preston to Birmingham. My Rt. Hon. Friend the Secretary of State for Scotland for his part intends that in the course of the four-year period a start will be made with a crossing of the Firth of Forth. A scheme for the construction of a tube on the bed of the Firth of Forth has recently been submitted to my Rt. Hon. Friend by consultants of high standing as a less expensive alternative to a bridge. It is being referred to the local authorities concerned, with whom we are ready to discuss how its merits in relation to a bridge can best be assessed. Once this has been done, decisions can be taken as to the starting date for the selected alternative.

"The effect of the proposals now put forward is that the work authorised in the financial year 1955–56 will represent an ultimate expenditure from the Exchequer of approximately £27,000,000 and the total to be authorised during the following three years will involve an ultimate Government expenditure of about £120 million. This excludes expenditure on the very large projects of national importance to which I have just referred. There will also be the substantial complementary expenditure of local highway authorities on classified road schemes. The House will realise that on a programme of this sort it takes some time for payments to reach the level of authorisations, the actual expenditure on most schemes being spread over a number of years like the constructional work itself, and falling for the most part two or three years after authorisation. I do not think it would be appropriate for me to forecast now the precise scale of the programme in years further into the future. The actual amount of work to be authorised must clearly depend on the resources available and on the economic and financial condition of the country at the time. But it is the Government's firm intention to continue with a substantial programme of road construction and improvement—at least on the scale I have indicated—until the roads of this country are adequate for the traffic they have to bear."

The following are the lists of schemes referred to in the Minister's statement, including certain schemes previously announced :—

*A. Schemes in England and Wales proposed to be authorised in 1955–56 on trunk roads (each costing over £100,000) and on classified roads (each costing the Exchequer over £500,000)*

| | |
|---|---|
| Alconbury Hill to Woolpack Cross Roads (second carriageway) | A.1 |
| Allerton Station (Hopperton) By-pass | A.1 |
| Browney Bridge to Farewell Hall, widening | A.1 |
| Borrowash By-pass | A.52 |
| Catterick By-pass | A.1 |
| *Dartford-Purfleet Tunnel | — |
| East Retford By-pass (Elkersley By-pass to Five Lane Ends) | A.57 |
| *Elephant and Castle improvement (Part I) | A.3 |
| Handcross By-pass | A.23 |
| Lichfield-Burton Road (part), second carriageway | A.38 |
| Longton By-pass | A.59 |
| Neath By-pass (Part II) | A.48 |
| Newcastle boundary to Chapel House, Throckley (widening) | A.69 |
| Oxford boundary to Islip Turn (widening) | A.40 |
| Page Street to Mill Hill (second carriageway) | A.41/A.1 |
| Potter Street diversion, Harlow | A.11 |
| Ryton-on-Dunsmore to Coventry (second carriageway) | A.45 |
| Shenstone, widening carriageway for 1 mile east of A.38 | A.5 |
| Stamford boundary to Kesteven boundary (widening) | A.1 |
| Stratford Road, Shirley (widening) | A.34 |
| Tabernacle Chapel to Llanfair Discoed Arches | A.48 |
| Western Avenue, second carriageway between Park Royal Station and Greenford Halt (Part II) | A.40 |
| Woodbridge By-pass, widening carriageway | A.12 |

* Classified road scheme. Pending further consultation with the local highway authorities responsible for initiating schemes on classified roads it has been considered desirable to exclude schemes below £500,000 (Exchequer cost). It is, however, expected that Exchequer expenditure will be divided about equally between classified road schemes and trunk road schemes below £500,000.

*B. Schemes in Scotland proposed to be authorised in 1955–56 (each costing the Exchequer over £100,000).*

| | |
|---|---|
| Trunk : | |
| Bridge of Allan | A.9 |
| Dumbuck to south-east of Barloan Crescent | A.82 |
| Linlithgow Bridge | A.9 |
| Trunk and classified : | |
| Bridge of Don, Aberdeen | A.92 |

*C. Schemes in England and Wales proposed to be authorised in 1956–57, 1957–58, and 1958–59 (each costing the Exchequer over £500,000).*

*(i) London-Yorkshire Motor Road*

The programme provides for the construction of the London-Dunchurch (for Birmingham) section of the London-Yorkshire Motor Road. It will be built to modern engineering standards and restricted, under the powers given by the Special Roads Act, 1949, to motor traffic only. No frontage access will be permitted and the motor road will be carried over or under all roads by means of fly-overs, connections being provided with the principal main roads, designed so as to keep the different streams of traffic in continuous movement.

This section starts at the northern end of the proposed St. Albans By-pass, which itself will be constructed to motor road standards, and passes to the west of Luton in Bedfordshire, thence through the eastern end of Buckinghamshire, entering Northamptonshire near Hanslope. It crosses the trunk road A.45 about half-way between Weedon and Northampton and reaches trunk road A.5 about 1½ miles north of Ashby St. Ledgers.

At this point a spur for the Birmingham traffic runs westwards, crossing the Northamptonshire/Warwickshire boundary about 2½ miles south of Rugby and terminating at the eastern end of the Dunchurch By-pass.

Beyond this point the Birmingham traffic will use the existing trunk road A.45, which will have dual carriageways, together with by-passes at Dunchurch and Meriden.

The programme also includes the provision of dual carriageways from the Hampstead Borough boundary at Finchley Road to the commencement of the St. Albans By-pass, as well as the construction of a by-pass to Doncaster which forms the terminal point of the complete motor road.

| | |
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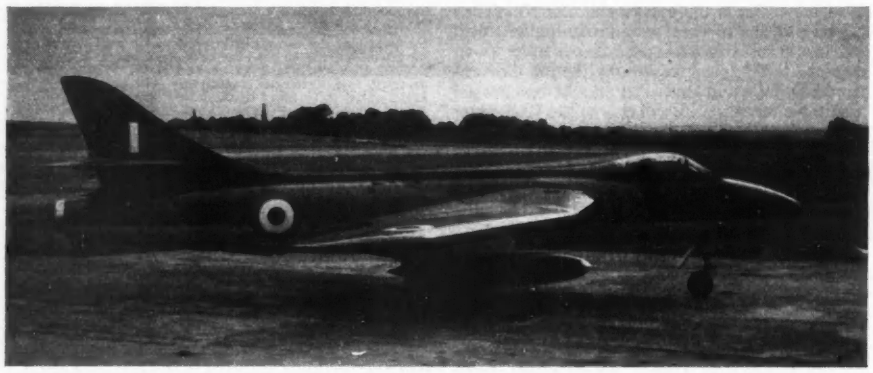
| *(ii) Trunk Roads* | |
| Angel Road Bridge, Edmonton | A.406 |
| Brynmawr-Abergavenny | A.465 |
| Doncaster By-pass | A.1 |
| Gateshead-Felling By-pass (part classified) | A.184 |
| Grantham By-pass | A.1 |
| Harlow By-pass | A.11 |
| Hirwaun-Brynmawr | A.465 |
| Kingston By-pass, second carriageway between Robin Hood Gate and Burlington Road | A.3 |
| Lancaster By-pass | A.6 |
| Maidenhead By-pass | A.4 |
| Maidstone By-pass | A.20 |
| Northwich By-pass (completion) | A.556 |
| Oxford Ring Road (Botley to Wolvercot) | A.34 |
| Port Talbot By-pass | A.48 |
| Preston By-pass | A.6 |
| Ross Spur | — |
| St. Albans By-pass | A.5 and A.6 |
| Sandiacre-Stapleford By-pass (Derby) | A.52 |
| Stafford-Stoke road widening | A.34 |
| Staines By-pass | A.30 |
| Tilbury Docks approach road | A.13 |
| Western Avenue-Hangar Lane flyover | A.40 |
| *(iii) Classified Roads* | |
| Albert Bridge reconstruction | B.304 |
| Barton Bridge, Lancashire | A.575 |
| Blackwall Tunnel, northern approach road | A.102 |
| City of London redevelopment—various schemes | — |
| Elephant and Castle improvement (Part II) | A.3 |
| Holborn-Kingsway junction improvement (Part I) | A.40 and A.4200 |
| Huddersfield Central Ring Road (southern section) | — |
| Laira Bridge, Plymouth | A.379 |
| London Road-Chester Road, Manchester (East-West link road) | A.57 |
| Manchester Outer Ring Road | A.575 |
| Notting Hill Gate improvement | A.40 |
| Strand widening | A.4 |
| St. Giles Circus (Part 1, S.E. corner) | A.40 |

*D. Schemes in Scotland proposed to be authorised in 1956–57, 1957–58, and 1958–59 (each costing the Exchequer over £500,000).*

| | |
|---|---|
| *(i) Trunk Roads* | |
| Abington and Crawford Diversions (including intervening lengths) | A.74 |
| Auldton Heights to 1·7 miles south of Millbank | A.74 |
| Beattock to Johnstone Bridge | A.74 |
| Dalmakether to North end of Lockerbie Diversion | A.74 |
| Glasgow-Stirling Road | A.80 |
| Improvement from Malletsheugh to Eastwood Toll | A.77 |
| *(ii) Classified Roads* | |
| Whiteinch Second Tunnel | |

# Standardised Drop Fuel Tanks

RECOGNITION of the need of most existing and projected aircraft for additional and necessarily external fuel capacity has led to the development of plastic drop tanks in a limited range of sizes and having standard attachment details. Certain tank sizes have common end cones and a centre cylindrical section of common diameter, the length varying according to capacity. Plastics have been chosen to replace the aluminium alloy normally used, for when made in the quantities envisaged they can be produced more quickly and cheaply—a 30 per cent saving in cost is envisaged—and the material is not a strategic one. The advantages bestowed on production, supply and maintenance by standardising the shell components and the aircraft and tank attachment need no emphasis. Large-scale production of these tanks is to be undertaken by the Bristol Aeroplane Company, Ltd., where a development programme has been in hand for nearly three years.



These podded tanks fitted to the Hawker "Hunter" are said to have very little effect on performance

The general adoption of podded fuel tanks is indicative of a conflict affecting range and endurance which has been with the jet aircraft since its early days. Whilst thrusts and corresponding rates of fuel consumption have rapidly increased, internal fuel stowage capacity has correspondingly decreased in accord with high-speed aerodynamic requirements. The trend is strikingly illustrated when the endurance of a typical twin-pistoned engine fighter is compared with one of the latest supersonic prototype fighters. In the former category, endurance would be of the order of six hours on a fuel capacity of about 600 gallons stowed in a relatively large fat wing. A supersonic machine having a jet engine of 15,000 lb static thrust and an additional 10,000 lb reheat thrust has been stated to register a fuel demand during take-off and initial climb of about 10,000 gallons per hour, reducing by at least a quarter, according to height and Mach number. Such a machine would have a very thin wing and a slim fuselage, but supposing accommodation for 1000 gallons was provided it can be deduced that the endurance cannot be more than about twenty minutes under optimum conditions.

Although the range and endurance of present transonic aircraft is much less critical, both are considerably enhanced by the use of drop tanks. These have for several years been used extensively on American aircraft, where, with bomber aircraft, podded engines as well as fuel has been adopted in preference to internal mounting.

It is reported that drop tanks constituted the largest single item of expenditure by the United States Air Force during the Korean War, where thousands of tanks, each costing, say, £200 or £300 each, were expended every week.

### Development

The standard sizes so far developed have the following capacities: 50, 100, 150, 200, 300 and 500 gallons. The front and rear shells of the 100 and 150 gallon drop tanks are the same; the larger tank having a longer centre shell. The 200 gallon and 300 gallon tanks also have common front and rear shells.

The techniques developed by the company for primary structures—the moulding of cylindrical fuselage sections by the autoclave process and the hydraulic-press moulding methods used for wing sections and frames—have both proved adaptable for the manufacture of drop tanks, the former for the shell and the latter for the internal framework. All the tanks consist of three main shell sections with high-pressure-moulded internal frames assembled by hot gluing.

The complete manufacturing process has been planned with the object of using the simplest possible tools and processes, so that it is not necessary to use elaborate plant or skilled labour for production. The basic aerodynamic shape of the standard tanks was the work of the Royal Aircraft Establishment, Farnborough.

Good jettison characteristics are ensured by fitting an adjustable incidence fin which is designed to counteract any pitching moment when the tank falls away.

A 77 gallon standard plastics drop tank designed for the Hawker "Sea Hawk"

Provision is also made for various kinds of air/fuel connection to be screwed into the tank ports so as to meet the requirements of varying designs. An automatic float-switch can be fitted which cuts off the fuel supply when tanks are full if pressure-fuelling is being used instead of gravity feed. The pick-up point on the tank is designed to fit on the standard bomb or underwing stores attachment point of military aircraft. The pick-up can readily be adapted to fit the two-lug American type mounting or a jettison gun mounting.

Plastic tanks can be manufactured to give a finer surface than aluminium tanks and tests have shown the material to be unaffected by extremes of temperature and humidity. A metal nose cap increases erosion resistance.

The 100-gallon tank, which is shown on the Hawker "Hunter," has flown on that aircraft at supersonic speeds without affecting performance.

The three-section design was chosen to give the optimum in ease of storage and time of assembly after storage. The shells of several tanks can be put together to give a nesting ratio of about 3 : 1.

The shell sections and the detachable tail fin, if used, are assembled by bolting simple mechanical joints. No glue is required and the tanks can be assembled in the field by two or three unskilled men in about ten or fifteen minutes, and can also be quickly broken down after an operation and stored again.

## Australian Iron Ore Ship "Iron Whyalla"

SINCE 1935, when Australian Iron and Steel, Ltd., amalgamated with the Broken Hill Proprietary Company, millions of pounds have been spent by the two companies in developing their respective steel plants at Port Kembla and Newcastle, in New South Wales, which will soon have a combined output of about 2,250,000 tons of steel per annum. Considerable sums have also been expended in developing their collieries in the vicinity and their iron ore mines far afield in South and Western Australia. New iron ore deposits have been opened up at Yampi Sound on the north-west coast and at Whyalla, in the Spencer Gulf, South Australia, which had hitherto been their only source of supply of iron ore. A deep water harbour has been dredged and a shipbuilding yard—the largest in Australia—has been constructed with the primary aim of enabling the companies to build their own steamers for the transport of iron ore. Since the war four vessels of 12,500 deadweight tonnage have been built to the Broken Hill Proprietary Company's own design for the round trip of 6000 miles from Yampi Sound with iron ore to Newcastle and Port Kembla and coke and coal as back loading.

Details have recently been issued of the latest ship, S.S. "Iron Whyalla," to be launched from the Whyalla shipyard. She is the twenty-third ship to be constructed at this yard and is a vessel of 10,000 tons deadweight built to the Broken Hill Proprietary Company's own design. After commissioning in June, she sailed with a cargo of 10,000 tons of iron ore for Port Kembla, subsequently proceeding to Sydney, where she was dry docked for inspection, cleaning and painting, in accordance with the company's usual practice, following a ship's maiden voyage. The docking was of particular interest as special measures had been taken to make the hull more effectively resistant to corrosion. After launching, ships are berthed for a considerable period while being fitted out. It is during this time of the vessel's idleness that corrosion begins. To protect the "Iron Whyalla" against corrosion during fitting-out, a departure from customary practice was made. In addition to the painting (prior to launching) of the vessel's shell plating with primer and anti-fouling preparations, the vessel while at the fitting-out wharf had the benefit of cathodic protection. It is believed that this is the first time that this form of protection for ships has been used in Australia. The precautions taken were successful.

The planning associated with the "Whyalla"

class vessels goes back to 1947, when Mr. Essington Lewis, in his then capacity as chief general manager of B.H.P., directed that design of this class of steamer should be put in hand, incorporating the following features: deadweight lifting capacity of 10,000 tons; four cargo holds; vessels to be coal-fired, the coal being fed mechanically to the boilers and the ashes to be automatically removed and ejected overside; service speed to be 14 knots. The vessel is of the complete superstructure type with tonnage opening and has a designed service speed at load draught of 14 knots. Her hull, machinery and equipment are in accordance with the requirements of Lloyd's Register of Shipping for their class plus 100 A1. The principal dimensions of the "Iron Whyalla" are as follows:—

| | |
|---|---|
| Length overall | 498ft |
| Length between perpendiculars | 475ft |
| Breadth moulded | 62ft |
| Depth moulded to upper deck | 38ft 6in |
| Depth moulded to second deck | 30ft |

The sequence of compartments as from forward, is fore peak tank, numbers one, two and three holds, deep tank, self-trimming coal bunker, boiler room, engine room, number four hold above tunnel flat (with side tanks under tunnel flat) and aft peak tank. The hull construction is of the combined longitudinal and transverse framing system; wing tanks have been arranged under the second deck in numbers one, two and three holds for the carriage of water ballast only. Welding has been used to a greater extent in this design than in previous ships built at the Whyalla shipyard, some 43 per cent of the weight of the hull having all-welded connections. Parts welded include the tank top plating, second deck plating and upper deck plating in way of the accommodation. Also welded are the main and 'tween deck bulkheads and shell plating butts.

### Main Machinery

The main propelling machinery consists of a double-reduction geared turbine unit of Parsons Marine Steam Turbine Company, Ltd., design and manufacture. It is designed to develop a service power of 6200 s.h.p. continuously at 115 propeller revolutions per minute and an overload of 6820 s.h.p. The gearing is of double reduction, double helical "articulated" type, the main and secondary wheels being fabricated with forged steel rims and shafts. Steam is generated by two Babcock and Wilcox water-tube boilers of the cross-drum header type with water walls; they have a maximum continuous rating of 30,000 lb per hour per boiler with the superheater outlet at 730 deg. Fah. and 430 lb per square inch. These boilers are coal-fired by mechanical stokers of the Babcock and Wilcox "Detroit Rotograte" type from hoppers fitted to the coal bunker bulkhead. These are filled periodically from the self-trimming coal bunker by completely mechanical means. An automatic ash handling system of the "Hydro-vac" suction type made by Babcock and Wilcox provides for mechanical handling of all ash from the boiler plant as in shore installations. All necessary fans, pumps and stoking gear for the steam generating plant are electrically driven except the ash disposal ejector pump, which is steam turbine driven. The d.c. electrical power supply is produced by four diesel-driven generators which enable the steam generating plant to be shut down completely for periods in port. Each unit consists of an Allen "3T47" diesel engine directly coupled to an Allen open canopy type, 218kW, 220V, d.c. compound wound generator. All engine-room auxiliaries are electrically driven except the steam turbine-driven main feed pumps.

### Deck Machinery

There is complete absence of derricks with which such vessels are usually equipped. Cargo gear is provided at No. 3 hatch only for handling ships' stores and occasional parcels of cargo. The reason for this is that the vessel is designed expressly for the carriage of bulk cargoes of iron ore, limestone, coal and coke. The method of loading and discharge of these products makes the conventional derricks superfluous. The design of the vessel, however, allows for the provision of cargo gear at all hatches should they be required. All hatch covers on the shelter deck are of steel "MacGregor" patent design of the single-pull rolling type, arranged so that they are flush when in the closed position and stowed at the ends of the hatchways when open. The rolling and the pivoting of these covers is carried out by the cargo handling gear. Trimming boards have been incorporated which minimise the raking out of the corners and ends by the discharging ore grabs. The "Iron Whyalla" is fitted with modern aids to navigation, including radar equipment, gyro compass direction finder and echo-sounding depth-recording apparatus. All accommodation for officers, engineers and crew is situated above the shelter deck in a single house slightly aft of amidships. Each crew member has a separate cabin of generous dimensions with single berth accommodation complete with wardrobe, book shelf and reading lamp. The crew are also provided with a spacious recreation room and a mess room complete with generous refrigeration equipment. Mechanical ventilation of Thermotank, Ltd., design is fitted throughout. The current programme of the Whyalla Shipyard includes the fitting out of S.S. "Yanderra," a 4750-ton collier for the Australian Shipbuilding Board, launched over a year ago. Work on the second "Whyalla" class vessel has been temporarily suspended to give priority to the construction of vessels for the Australian Shipbuilding Board. The second 4750-ton collier, S.S. "Yarrunga," was launched on October 2nd. She will be followed by a 10,000-ton bulk cargo carrier, the keel of which was laid in February, 1953.

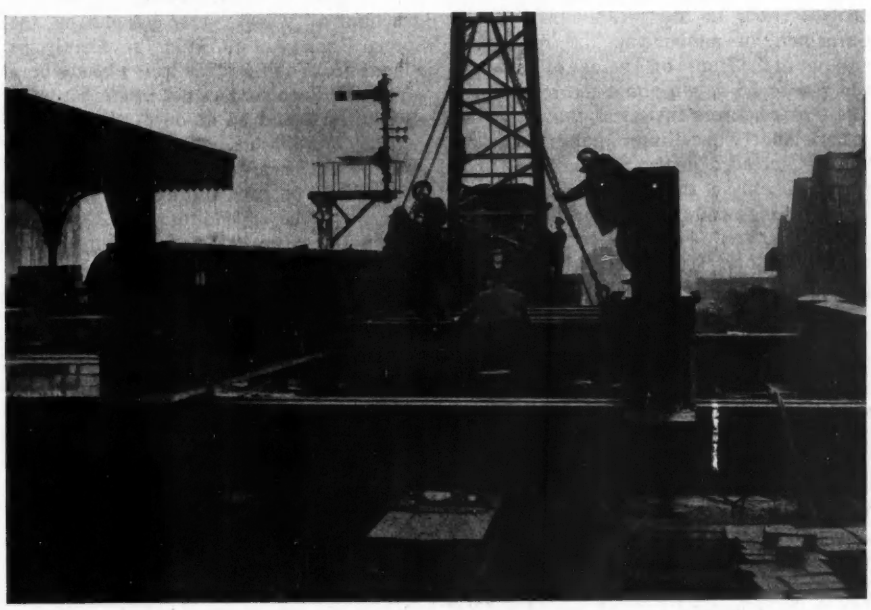
## Railway Bridge Renewal Problem

The replacement of a railway bridge involving some difficult engineering problems was recently completed by the London Midland Region of British Railways. The bridge which was renewed is over Green Lane, Patricroft, and carries the four main lines between Manchester Exchange Station and Liverpool. At this site the bridge forms part of the station, and although only of one span of 34ft 6in, it comprises independent structures carrying the platforms, the two fast lines and the two slow lines. The two structures carrying the tracks are separated by one carrying an island platform. The track-carrying structures consisted of wrought iron main girders, with cross girders and trough rail bearers, in which rested short lengths of longitudinal timbers, spanning between the cross girders. The construction depth was extremely shallow and the headway under the bridge of 13ft 9in was about the minimum for double-deck buses. The line is heavily used and at this point railway traffic passes at high speed, with the result that the shallow wrought iron trough rail bearers and cross girders had suffered to such an extent as to necessitate reconstruction of the two spans carrying the railway.

It was decided that, if possible, sleeper tracks should be provided for the new design, but as the existing headway could not be altered and existing rail levels had to be maintained because of the difficulties which would have been encountered in raising the station platforms, it was apparent that with a construction depth of 1ft 8in the minimum depth under the sleepers would be 7½in. It was also evident that the erection problem would be difficult, and some form of prefabricated construction which could be erected *in situ* would be needed because the station platforms made it impossible to adopt the rolling-in method. A further complication would arise in using railway cranes, which would be restricted by the station platforms and awning roofs.

The design adopted for each span consists of three welded steel main girders of 34ft 6in span, with shallow welded steel trays suspended between them, the underside of the trays being flush with the underside of the bottom flanges of the main girders, and the upper edges of the trays having the running rails passing over them. Each tray accommodates two sleepers at 2ft 6in centres, the width of the tray being 5ft. The sides of each tray were made from rolled steel sections and the bottom consists of ½in thick steel plate welded to the lower flanges of the frame. The plate was stiffened by welding steel channels to its upper side with their flanges reduced in width. The whole of the inside of each tray was waterproofed at the fabricators' works, and drainage outlets were provided through the webs of the main girders into gutters. The trays were connected to the main girders by shear plates bolted to the main girder stiffeners.

Falsework was first erected on the platforms spanning across the tracks, so that the new superstructure could be erected on it, immediately over the final position to which it was to be lowered. The lowering of each span was carried out by two breakdown cranes, one at each end of the span, lifting from special beams attached to the ends of the girders, the falsework being removed from under the span after the weight had been transferred to the cranes. The whole of this work was carried out in two weekend possessions. The bridges were designed by the regional bridge office under the direction of Mr. J. Taylor Thompson, chief civil engineer of British Railways, London Midland Region, and the fabrication and erection was carried out by the Butterley Company, Ltd., with Fletcher and Co., Ltd., as sub-contractor.



**Two main girders are here shown erected on falsework above their final position and floor trays are being fixed to them**

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## THE ROAD PLAN

Considering the short time interval between the announcements, it is not possible to avoid making comparisons between the British Transport Commission's plans for the railways and the Government's plans for the roads. The comparison cannot, of course, be quite fair. For the railway plan applies to vehicles as well as tracks, whereas the road plan applies to tracks alone ; and allowance should be also made for ton-miles of freight and passenger miles of people carried. But even so the Government does not come very well out of a comparison which reveals that the railways are determined to start schemes within five years costing in all £1200 million, and complete them in fifteen, and that on the roads schemes costing £147 million are only to be approved, not necessarily started, in four years. Mr. Boyd-Carpenter, in announcing the road programme in the House on Tuesday of last week, was not to be drawn about the real annual rate of expenditure envisaged, though he did remark that expenditure upon motorways was not included in the £147 million. The point probably is that Governments cannot lay down plans of expenditure extending far into the future. For they cannot commit their successors. Yet there is a striking disparity between the methods of financing improvements in the two forms of competing transport and one that appears to be all to the disadvantage of the roads.

In this country there must be very few sections of main road of even so short a length as 10 miles which cannot be criticised as falling in some way far below safe and economic standards. In those circumstances, though every road user can think from his own experiences of projects, already planned or still nebulous, that urgently need to be carried out, selection for early attention has had to be influenced by such considerations as the state of preparedness of schemes and the availability of land. It is, indeed, the utter inadequacy of most of the main roads that is the justification for spending money on the construction of entirely new motorways upon entirely new alignments. For to attempt now to lift existing roads up to the highest modern standards would be immeasurably expensive. Other countries in Western Europe—not to mention the United States—long ago reached that conclusion. Alone, this country—perhaps because its sadly defective major highways are relieved by a diversity unexampled elsewhere of well-surfaced main roads—has lagged behind in the construction of motorways. The two motorways to be begun, presumably within four years, the London-Yorkshire and Birmingham-Lancashire roads, both lie broadly upon alignments envisaged by the Ministry of Transport in 1946, powers for the construction of which were granted by the Special Roads Act of 1949. Presumably the alignments of those roads have already been surveyed. But that does not mean that work upon them could be at once begun. Procedures for publishing details of the schemes and, if necessary, holding public inquiries have still to be gone through. Apart from motorways, the expenditure of £27,000,000 to be approved in 1955/56, and that of £120 million to be authorised in the following three years, relate to a variety of projects, a list of which will be found on page 199 of this issue. Many detailed criticisms could be made, particularly about urgently needed schemes omitted. But if criticism is to be voiced at all, when, after so many years' neglect, a start upon improvement is at long last made, it should relate, we think, not to the major highways, but to the omission to envisage really drastic developments to relieve congestion in large cities. Certain schemes are, indeed, to be authorised in London. Yet in relation to the rate of growth of congestion they amount to little more than tinkering with a problem that has repeatedly been examined, repeatedly been shown to be soluble only by the carrying out of really large-scale works and just as repeatedly been shelved. There was weight as well as political opportunism in Mr. Callaghan's jibe that motorways sounded very fine, but if they did not start anywhere and did not lead anywhere they could not relieve congestion very much ! The time may well come when traffic will take longer to travel from the City of London to Barnet, than from Barnet to the outskirts of Birmingham, and as long again to reach the centre of that city.

But though there are plenty of uncertain factors about these road plans, and the most uncertain of all is the real rate of expenditure contemplated by the Government, one thing is certain enough. The road-making plant is available. Even if Boyd-Carpenter's statement can really be read to mean that the Government's expenditure on road construction and improvement will exceed £40,000,000 per annum within four years—a public disillusioned by broken past promise is likely to adopt a "seeing is believing" attitude—the corresponding rate of construction will still be low relative to the capacity of the civil engineering industry. Experience during the war—not forgetting the important contributions of the Road Research Laboratory—has put into the hands of contractors much modern plant and much knowledge of new methods. Less than about 2 per cent of the earth-moving equipment available would be needed to carry out such a programme. By using methods of soil stabilisation foundations nowadays can be prepared at a rate of 200 yards or more a day. Concrete can be laid at a rate as high as 350 yards a day of single carriageway. The demand upon bitumen surfacing machines, at any likely level of road construction, would not amount to more than a small fraction of capacity. Indeed, far from calculating whether the civil engineering industry has the capacity to undertake road construction at the rate envisaged, we are driven to wonder whether the contemplated rate of expenditure will be sufficiently high to make the work of road-building and improvement as economic as, given a high output, it could be. Let it be hoped that contracts will be individually large enough to justify the use of the most modern methods of construction.

## MINES INSPECTION

In the opening paragraph of his Report for 1952, the publication of which was recorded in our last issue, Sir Harold Roberts, Chief Inspector of Mines, remarks on the long delay in its preparation. He attributes it to additional work imposed on his depleted and already overburdened staff. At the end of the year there was a deficiency of as much as 20 per cent in the authorised establishment of the whole Mines Inspectorate, and it was no less than 28 per cent in the two largest classes which carry out the majority of the field work ! No doubt competition from the National Coal Board and the supply industries for the services of suitable mining engineers accounts for some of this shortage. But such competition seems now to be permanent and should surely now require recognition by those responsible for recruit-

ment. The situation is, of course, but one aspect of a national problem which has been brought to particular public notice recently by the search for technicians to staff the new or projected atomic power plants, but which is being felt in almost every industry in the country. It is the more serious in the Inspectorate because it occurs at a time when reorganisation and development in the mines, especially the extended use of new types of machines and equipment underground with consequent introduction of new legislation, are proceeding apace.

The number of persons killed in the mines in 1952 was a new low record, 420, compared with 487 in 1951 and an average of 583 in the previous ten years. Very nearly half of the fatalities underground was again in the category "falls of ground," and the second biggest number under haulage ; in this the other main category of accidents the number of deaths increased by twenty-two compared with the previous year, but was less by thirteen compared with the average for the previous decade. Immunity from a major disaster by fire or explosion, in which category there was a reduction of ninety-two compared with the previous year, accounted for much of the overall improvement. There was no change in the number of fatalities in shafts and on the surface in the last ten years, a state which Sir Harold calls one of stagnation which constitutes both a reproach and a challenge. Moreover, the number of persons seriously injured from all causes increased from 1,942 in 1951 to 2,109 in 1952, so that the total persons killed and reportably injured increased by 100 during the year. What appears to be a surprisingly large number of minor accidents, causing disablement for more than three days, occurred in the mines. They again amounted in 1952 to about one for every three persons employed, 238,100 out of 744,000 persons. The average number of days lost per person injured was twenty-eight. However, though the number of such accidents has increased rapidly during recent years, it is well known that the figure depends on factors other than the general safety condition of the mines, such as changes in workmen's compensation and industrial injury benefits, the effect of a high rate of income tax, as well as encouragement given to miners to report all injuries, however trivial, and have them properly treated. Other industries may well note the concern expressed by the Chief Inspector of Mines for the dangers associated with the generation and transmission of compressed air. No less than six serious explosions or fires occurred in this way during 1952, fortunately without loss of life ; but four of them were particularly serious and were investigated by the Principal Inspector of Mechanical Engineering in Mines. He found grave defects in the compressor plants used and in the standards of installation and maintenance. For example, a violent explosion in a 14in diameter main carrying air at 80 lb per square inch occurred at the top end of a downcast shaft, and caused damage which stopped coal winding in the shaft for nine months. Air was being supplied by three compressors at the time. The pipe from one compressor to the air receiver was so arranged that for a length of 25 yards nearest the compressor it was situated below the levels of its ends, yet no drains for the release of oil or water were fitted. In some places the pipes had been reduced in thickness from about 0·365in to 0·10in by corrosion. The receiver had two lever-type safety valves fitted, but the effective lift of one valve was reduced to $\frac{1}{16}$in by a carbonaceous deposit on the valve spindle. Other defects found after the four incidents were inadequate filtering arrangements on the air intake, and ineffective thermometric devices for warning or for automatically stopping electrically driven compressors in the event of excessive temperature reached in the discharge air—the latter fault often due to excessive thermometric lag arising from poor design and installation. A list of twenty-two recommendations given in the Report is based on experience gained from such investigations, and if implemented would greatly reduce such accidents.

Fires are still caused too frequently by belt conveyors, usually by frictional heating at a roller or drum. For this reason trials were in progress during 1952, under the supervision of the National Coal Board Field Investigation Group, to determine the behaviour of various types of non-inflammable belting by comparison with one another and with rubber belting (B.S.S. 490) in relation to wearing properties and development of flaws. Conveyor belts made with the plastic —P.V.C.—were found to be affected by changes in atmospheric temperature. The plastic hardens as it becomes colder and is then more liable to crack and to slip on the driving drum. Slip can lead to overheating, which causes the material to soften locally and distort, this being a probable cause of the belts floating out of line. But separation of the plies in P.V.C. belting has been the most frequent cause of failure with this type of belt hitherto. Now that incombustible brattice cloth (with plastic covering) is available, it is intended to devise specifications to ensure its use ; and Sir Harold expresses the hope that security will eventually be achieved in the case of conveyor belts.

## Letter to the Editor

*(We do not hold ourselves responsible for the opinions of our correspondents)*

### A PROBLEM IN MENSURATION

SIR,—This problem originated in the need to determine the volume of a vertical cylindrical dome mounted symmetrically on a horizontal cylindrical tank, but it is evident that the basic problem in this case is the determination of the volume common to two right circular cylinders whose axes intersect at right angles. This can be found as follows :—

Let $a$, $b$ $(a>b)$ denote the radii of the horizontal and vertical cylinders respectively and let $b/a=n$. Using polar co-ordinates in a horizontal plane, with origin at the point of intersection of the axes of the cylinders and initial line in the direction of the horizontal axis, it is easily shown that the required volume may be expressed in the form

$$V=8\int_0^b\int_0^{\pi/2} r\,d\theta\,dr\,.\,\sqrt{a^2-r^2\sin^2\theta}$$

$$=8a^3\int_0^n\int_0^{\pi/2}\sqrt{1-k^2\sin^2\theta}\;k\,dk\,d\theta$$

$$=8a^3\int_0^n kE\,dk,$$

where $k=r/a$ and $E$ is a complete elliptic integral of the second kind, to modulus $k$.

By aid of the relations

$$\frac{dE}{dk}=\frac{E-K}{k}$$

and

$$\frac{dK}{dk}=\frac{E-k'^2K}{kk'^2}$$

it is a simple matter to show that

$$3kE=\frac{d}{dk}[k^2E+E-k'^2K],$$

where $K$ denotes a complete elliptic integral of the first kind to modulus $k$ and $k'$ is the complementary modulus, i.e., $k'^2=1-k^2$. Derivations of the above relations will be found in Bowman's *Introduction to Elliptic Functions.**

On substituting the value of $kE$ in the above integral we obtain finally

$$V=\frac{8}{3}a^3[(1+n^2)E-(1-n^2)K],$$

the moduli of both $E$ and $K$ being now equal to $n$.

When the two cylinders are of equal diameter, i.e., $n=1$, the last result reduces to $16a^3/3$.

S. A. SWANN

University of Nottingham.

## Clean Air Bill

ON Friday last, in the House of Commons, Mr. Gerald Nabarro moved that his Clean Air Bill be given a second reading. At the end of the debate, however, he asked leave to withdraw the Bill, after the Minister of Housing and Local Government, Mr. Sandys, had stated that, during the present session of Parliament, the Government intended to introduce a comprehensive measure which would have all the financial provisions necessary to give effect to a clean air policy.

In the course of his speech containing this announcement, Mr. Sandys said that the Government was in agreement in principle with the policy advocated by the Beaver committee's report. The committee had defined the principles and objectives of a clean air policy, but the process of translating them into an Act of Parliament inevitably raised a number of points, some of which might be of great importance to large sections of the community and might involve technical problems of considerable complexity. The Minister went on to say that the implementation of a clean air policy would, of course, have considerable repercussions upon the design of industrial plant and upon industrial re-equipment plans in general. It would extend the responsibilities of local authorities and entail the recruitment of a substantial number of technical staff. If the new law was to be intelligible, practicable and reasonable, Mr. Sandys added, it must, the Government considered, be devised and framed in close consultation with those who would be most directly affected. In particular, the Government felt, there must be full consultation with local authorities, with industrial employers and trades unions, and with various technical bodies whose advice was needed. As soon as those consultations were completed, the Government would frame and introduce a comprehensive measure. The Bill would follow the general lines of the recommendations of the Beaver committee.

## Index to THE ENGINEER

THE Index to THE ENGINEER, Volume 198, July to December, 1954, is now ready and has been posted to all readers who have previously applied for copies. A copy will be sent free of charge to subscribers and regular readers of THE ENGINEER on application to the Manager, THE ENGINEER, 28, Essex Street, London, W.C.2.

* F. Bowman, *Introduction to Elliptic Functions, with Applications*, English Universities Press, 1953, page 21.

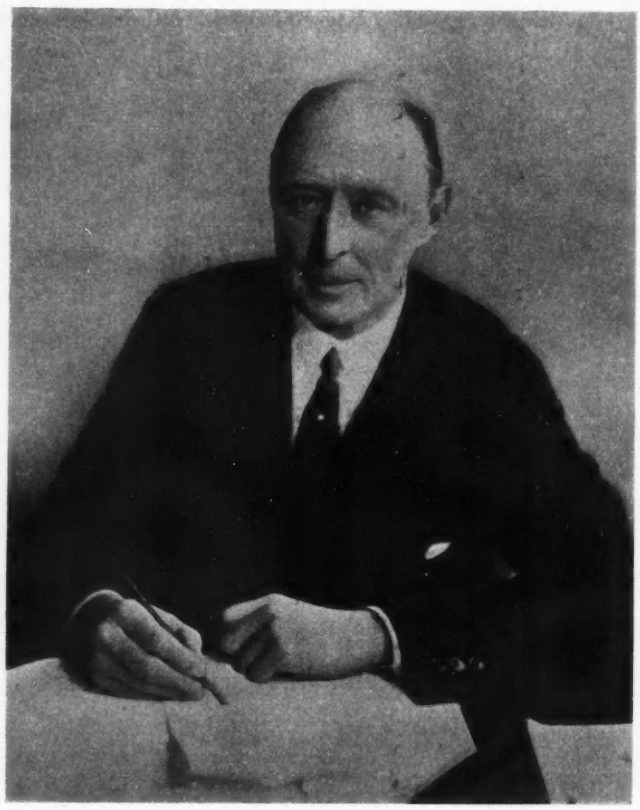
# Obituary

## SIR GERALD CHADWYCK-HEALEY

It is with a very deep and personal regret that we have to record the death on Wednesday of last week of Sir Gerald Chadwyck-Healey, Bt., C.B.E., at the age of eighty-one. Sir Gerald was the grandson of Mr. Edward Charles Healey, who founded THE ENGINEER in 1856. He came to THE ENGINEER in 1895 and was appointed a director in 1905. Thereafter, to the end of his life, the fortunes of this journal lay very close to his heart. He came to the journal at a particularly interesting time. Partly as one of the consequences of the invention of the typewriter, partly for social and other reasons, the organisation of office procedure was changing. At the same time the competition of other technical journals was demanding improved standards editorially. Sir Gerald found in the office, when he first came there, a young man of about his own age, Loughnan St. Lawrence Pendred, son of the reigning editor. In 1905, the year in which Sir Gerald became a director of the company, Lough Pendred succeeded his father as Editor. Before and after these events the two men, each in his own sphere, worked together to modernise office procedure and the presentation of editorial material. In the process, Sir Gerald conceived not only a respect, but a lively affection for his Editor, an affection that was very much reciprocated.

In 1919 Sir Gerald succeeded his father, the late Sir Charles Chadwyck-Healey, as chairman of the company, and when, in 1929, "The Engineer, Ltd.," amalgamated with the Morgan concern, proprietors of *The Ironmonger* and *The Chemist and Druggist* to form Morgan Brothers (Publishers), Ltd., he became chairman of the new company. After the amalgamation, as befitted a chairman, he took a great interest in those other journals. But always—and inevitably—considering his family's connection with it—THE ENGINEER remained the journal upon which his deepest care was bestowed. So that when, in 1945, the time came for Lough Pendred to retire from the editorial chair, the support Sir Gerald had always given to him was transferred unabated to his successor, not, the present Editor hopes, without some of the affection, too. In 1948, his chairmanship of the company came to an end, when he was succeeded by his brother, Mr. Oliver Chadwyck-Healey, the present chairman. But he remained a director for three more years before retiring in 1951.

But if the prime purpose of Sir Gerald's life was to watch over the fortunes of THE ENGINEER he had, besides, many other activities. When war broke out in 1914 he served with the Royal Naval Volunteer Reserve and later became, first, assistant to the Controller of the Navy, and, later, Director of Materials and Priority. For his services during the war he was made a C.B.E. and he was also appointed to the order of the Crown of Italy in the rank of Commander. From 1922 onwards he was a member of the Royal Commission on Awards to Inventors, which, after the first world war, just like a similar body at the present time, struggled to discover who really were the inventors of the many new devices used in that war, and to assess their value. In those post-war years, too, he took an active part industrially. From a time several years before the outbreak of the first world war he had acted unofficially in an advisory capacity to the late Sir R. B. Phillpotts, chairman of the small British Tabulating Machine Company, Ltd., which was destined so much to expand its output. In 1914, he was elected to its board and in 1934 he became vice-chairman. By that time the concern had become much larger and in 1935 Sir Gerald went to South Africa to meet the directors of the associated South African company, Hollerith Machines (South Africa) (Proprietary), Ltd. He retired from the company's service in 1951, by which time it had a very large factory in Belfast, in addition to its earlier works at Letchworth. He was also for many years chairman of A. G. Mumford, Ltd., a firm once famed for the manufacture of steam engines and reciprocating pumps, particularly for marine use ; feed water regulators and other devices. That firm was founded by Mr. A. G. Mumford in 1876, became a private company in 1906, and was converted into a public company in 1920. Sir Gerald, who had become acquainted with Mr. Mumford through his work at the Admiralty, became chairman in that year. Subsequently, in the difficult years of the early 'thirties, when orders were hard to come by, the decision was taken to wind up the company. In 1932, accordingly, it came to an end and G. and J. Weir, Ltd., of Glasgow, acquired all the existing patent rights of the company.



Sir Gerald Chadwyck-Healey

For many years Sir Gerald lived at Cranleigh, in Surrey. There he became first a director in 1920 and in 1925 chairman, of the Cranleigh Water Company, Ltd. At that time this company was a very small concern. But Sir Gerald was instrumental in negotiating its amalgamation with the Chiddingfold and District Water Company, Ltd. He remained chairman of the joint company, which expanded to serve eight parishes, until 1948, and was still a director when the company was absorbed by the Guildford, Godalming and District Water Board in 1952.

These and other activities brought Sir Gerald a wide acquaintance industrially, an acquaintance of particular value to this journal at a time when publicity services were less well developed than they have since become and personal acquaintance could do much to open access to sources of information that might otherwise have remained closed. But whatever the calls his other activities might make upon him it was always felt in this office that nothing else was ever quite so important in his life as the maintenance not merely of the prosperity of THE ENGINEER, but, more significantly, its repute as an engineering journal serving a great industry.

Sir Gerald had that remarkable quality, of particular value to those called upon to lead other men, of always seeming to be at hand when most the steadying factor in leadership is needed. He knew, too, the value merely of being present at times of stress even if there was little that he personally could do about it. Late in the second world war, for example, at a time when he was already past seventy years of age, one of Hitler's "V" weapons, late one night, shattered windows in this office and blew down internal partitions, scattered papers and did other damage. It was typical of Sir Gerald that next morning he was to be seen in his shirt sleeves giving encouragement to those cleaning up the mess. Sir Gerald always took a lively interest in the happiness and contentment of those who worked for Morgan Brothers, and, perhaps more particularly, for those who were concerned in editing and publishing THE ENGINEER. Throughout his chairmanship he had always liked, upon occasion, to wander around the office spending a few minutes talking to members of the staff, learning what was going on. After his retirement these visits became, perforce, less frequent. Alas, we can expect them no more ! Now, as those proud to be serving a journal that his grandfather founded and in whose future he took so very great an interest, we can pay only this tribute to his memory.

Sir Gerald is succeeded by the elder of his two sons, Mr. Edward Randal Chadwyck-Healey, M.C.

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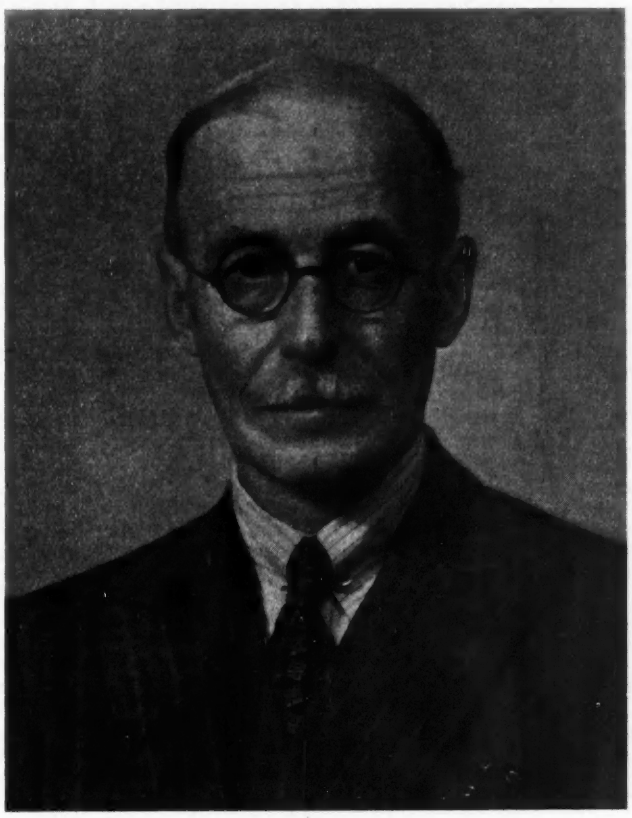
A short service was held at Holy Trinity Church, Ayr, on Friday of last week, and the funeral of the ashes took place yesterday, at St. Nicholas Church, Cranleigh, Surrey, of which living Sir Gerald had been patron for many years.

## SIR MAURICE EDWARD DENNY

ALL those engaged in the shipbuilding and marine engineering industries will have learned with profound regret of the death of Sir Maurice Edward Denny, Bt., which occurred at his home, Gateside House, Drymen, Stirlingshire, on Wednesday, February 2nd after a short illness. Sir Maurice, who was in his sixty-ninth year, had been actively engaged in shipbuilding and allied activities all his life and at the time of his death was president of William Denny and Brothers, Ltd., the well-known firm of shipbuilders and engineers. He was born at Dumbarton on February 11, 1886, and was the eldest son of Sir Archibald Denny, the first baronet and grandson of Peter Denny, who helped to found the firm of William Denny and Brothers in 1844. His family was closely associated with the Royal Burgh of Dumbarton, where his forbears, according to old records, were living in 1520 and where his great grandfather, William Denny, was engaged in the business of shipbuilding before the present concern was founded, a firm which is famous as the builders of the clipper "Cutty Sark," now preserved at Greenwich, and, in association with the Parsons Marine Steam Turbine Company, Ltd., the Clyde steamer "King Edward," the first merchant ship to be turbine driven.

Sir Maurice received his early education in his native town before proceeding to Tonbridge School, from where he went to Switzerland for a period of two years, followed by a final year in Germany. From 1903 to 1909 he served an apprenticeship, with William Denny and Brothers, on the sandwich system and during this period he spent some years in the United States, where he took a four-year course in naval architecture, studying under Professor C. H. Peabody at the Massachusetts Institute of Technology, where he graduated as a Bachelor of Science. On his return to this country he spent nearly a year with William Doxford and Sons, Ltd., the Sunderland shipbuilders and engineers, and then rejoined the family business as assistant to Leslie Denny and to gain further practical experience at the Leven shipyard. Two years later, in 1911, he was elected a partner of William Denny and Brothers and was appointed a director when the firm was converted into a limited liability company in 1918. A short time afterwards he became vice-chairman of the company and in 1922 he succeeded his uncle, Colonel John M. Denny, C.B., as chairman, and from that date for the next thirty years his administrative and organising abilities, which were of a high order, supported by his capacity for hard work, were to prove valuable assets to the Denny firm. Under his control the firm continued to enhance its reputation for building ships and turbine machinery, particularly with respect of fast cross-channel ships. In addition the company has been associated with Brown Brothers of Edinburgh with the development of the Denny-Brown stabiliser which was fitted to a number of naval vessels during the war and has formed part of the equipment of several large passenger ships built since the war, to minimise rolling and so add to the comfort of the passengers. In the realm of sport it is noteworthy that the firm built the yachts "Shamrock II" and "Shamrock III" for Sir Thomas Lipton to race for the America Cup. Some other achievements and activities of the company were recalled by Sir Maurice at the 1954 Autumn meeting of the Institution of Naval Architects when he mentioned the completion of the experimental tank by William Denny at Dumbarton in 1882, and the early work on model research, and rolling, and the development, from experiments started in 1905, of the first helicopter which successfully rose from the ground. Sir Maurice retired in 1952, Edward L. Denny becoming chairman, but continued to serve as a director and on January 1, 1953, took up the position of president of the company.



Sir Maurice Denny

During the first world war Maurice Denny went to France with the British Expeditionary Force and served as a major in the Machine Gun Corps and later became Deputy Director of Design in the department of the Deputy Controller at the Admiralty. For his services he was appointed a Companion of the British Empire in 1918. His activities at Dumbarton did not prevent Sir Maurice from taking a wide interest and an active part in the technical development of shipbuilding and the administrative affairs of the industry. For many years he played an active part in the Shipbuilding Employers Federation and also served, in 1940, a term as president of the Shipbuilding Conference. He was interested in the technical developments of shipbuilding and marine engineering and was active in his support of the technical societies. During the years before it was amalgamated with Lloyd's Register of Shipping Sir Maurice rendered yeoman service to the British Corporation Register of Shipping and Aircraft, of which he became honorary vice-president in 1941 and honorary president two years later.

The Institution of Engineers and Shipbuilders in Scotland recognised his work for the furtherance of shipbuilding and his leadership in the field of research by making him, in 1950, an Honorary Member of the Institution, a distinction which he shared with three others, one of whom is the Duke of Edinburgh. The Denny family always had close associations with the Institute of Marine Engineers and Sir Maurice was no exception and he was elected president in 1935–36, an office which was held by his father, Sir Archibald, in 1914 to 1916, by his grandfather, Peter Denny, in 1891–92, and by two other members of the family, namely, Colonel J. M. Denny in 1900 and James Denny in 1908–9. Another technical body to which Sir Maurice gave liberally of his time and experience is the Institution of Naval Architects, which he joined as a student in 1909; he became a member in 1918, served as a member of council, and was made a vice-president in 1935. His work for the Institution, which he represented on the Education Committee, the General Board of the National Physical Laboratory and the Advisory Committee of the William Froude Laboratory, was recognised by his appointment as Honorary Vice-President in 1950.

In more recent years Sir Maurice was closely concerned with research and development as represented by the British Shipbuilding Research Association, of which he has been not only a member of council since the formation of the Association in 1944, but also the chairman of the research board. At a joint summer meeting of the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders, held in Newcastle upon Tyne, Sir Maurice gave some account of the work and organisation of the Association in a paper entitled "The British Shipbuilding Research Association—The First Six Years." It was largely due to the initiative of Sir Maurice that the hull of the old Clyde paddle steamer, the "Lucy Ashton," was obtained for the purpose of carrying out full-scale resistance experiments. These went forward successfully and in 1951, during the London proceedings of the International Conference of Naval Architects and Engineers, he presented a paper with the title "B.S.R.A. Resistance Experiments on the 'Lucy Ashton,'" which reviewed the experiments.

He succeeded his father as baronet in 1936 and in the Birthday Honours of 1946 the K.B.E. was conferred on him, while in 1949 the honorary degree of LL.D. was conferred on him by Glasgow University.

As one of the great figures in shipbuilding, particularly Clyde shipbuilding, his death is a great loss to the whole industry.

# Literature

*Engineering Metallurgy.* By E. M. H. LIPS. Philips' Technical Library. London: Cleaver Hume Press, Ltd., 31, Wright's Lane, Kensington, W.8. Price 32s. 6d.

THE interdependence of metallurgy and engineering is generally recognised. The engineer continually demands specialised and improved quality in the materials which it is the duty of the metallurgists to supply; and, at the same time, efficient production in the metallurgical industries is more and more dependent on the engineer. This book was written, not as a text-book of metallurgy, but as a guide to the engineer, as a user, in the choice of the most appropriate working materials to meet his requirements. The user's main interest in metallurgy is in the ultimate products of manufacture, their properties and the final stages of their production. In every branch of engineering there is a demand for materials having special characteristics and standardised reproducible properties. The aim of this book is to provide practical data relating to the metallurgical materials now available to meet such demands. The seven main sections into which it is divided cover the mechanical properties of metals and alloys, corrosion, phase diagrams and their significance, alloys of iron with carbon and with other metals, non-ferrous metals and alloys, the heat treatment of metals, and the working and joining of metals. In the first chapter, the significance of the mechanical properties is clearly dealt with; but, although the American and European standard tensile test pieces are described, the British Standard test piece ($l=4\sqrt{a}$) is not mentioned. Some confusion arises in statements about the criteria of brittleness and toughness. The statements: "Brittle materials always have a smaller elongation than tough ones" (page 11) and "the work performed in the tensile test up to the point of rupture always remains a criterion of toughness" (page 13) are not always true of constructional materials. Later, it is stated that the notched bar impact test "gives results more in conformity with the practical concept of toughness." It is true, as the author points out, that other properties (for example, reduction of area) can often be correlated with impact value; but the energy absorbed in breaking a notched bar of specified dimensions has proved to be indispensable in eliminating materials in which brittle failure is liable to occur. In the second chapter, the theory of electrochemical corrosion is briefly dealt with, and some types of corrosion, their causes and methods of prevention, are described; but there is no mention of differential æration and its influence on pitting, or of cathodic protection.

The iron-carbon system is selected for the purpose of explaining the significance of phase diagrams; and, although this is a rather complicated example, the author proceeds, step by step, to discuss its implications, dealing with one region at a time, each aspect being illustrated by suitably annotated reproductions of the diagram as a whole or in part. After this full discussion, the significance of the diagrams appearing later in the book is readily appreciated. The chapters on the properties of iron, steel and non-ferrous metals and alloys, contain the essential data upon which a choice of working materials must be based. They include mechanical, thermal, chemical (in relation to corrosion) and, to some extent, electrical characteristics. The actual and potential applications of materials are recorded, and attention is directed to economic aspects of their use. There are bound to be some rather special subjects on which information is lacking (such as modern heat-resisting alloys); but, in the more general field, more detailed information about the mechanical properties of alloy steels would have been welcome, and also some mention of the latest developments in light alloys (for example, magnesium-zirconium alloys). Although there are scattered references to nickel steels, nickel-iron and nickel-chromium alloys, nickel is surprisingly absent from the list of the non-ferrous metals and alloys described.

The chapter on heat treatment deals adequately with a number of treatments in addition to the normalising, hardening and tempering of steel, and the annealing and precipitation hardening of non-ferrous alloys. It also includes stress-relief treatments, surface-hardening treatments and treatments to remove hydrogen embrittlement. The final chapter contains sections on shaping and forming of metals (machining, hot and cold-working and casting) and on the joining of metals (soldering, welding, riveting and sintering). Each is the subject of a brief general discussion in which the behaviour of a variety of materials is reviewed. The section on casting is confined to the simplest possible example. In view of the close link which should exist between the designer and the foundryman, it might have been amplified to bring out the importance of controlled directional solidification in more complicated castings. If the design is made to include sections which will have only the smallest possible cavities even though not directly fed, the foundryman has the better opportunity, by suitable feeding, the use of chills and other means, of producing a completely sound casting.

The book was printed in the Netherlands and this may account for the occasional misspellings, errors in spacing and peculiarities in the division of syllables at the end of a line. It is plentifully illustrated with diagrams, though a few of them suffer from excessive reduction and are difficult to read. The captions, which are sometimes of considerable length, are very helpful in making the diagrams self-explanatory. The translator, Mrs. A. H. Teves-Acly, must be congratulated on having made a good translation from the Dutch original. Technical terms are correctly rendered and the text reads smoothly. The information given has been carefully selected from many sources to meet the requirements of general engineering practice, and is imparted in a clear and attractive manner. Students will find it of value and it should appeal to designers in all fields of engineering as affording assistance in day-to-day problems and a sound basis for further specialised study.

*Engineering Dynamics, Volume IV.* By C. B. BIEZENO and R. GRAMMEL. Scotland: Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 50s.

THIS fourth volume of *Engineering Dynamics* deals with the internal combustion engine. The subject-matter is divided into three main sections: (*a*) Inertia Forces, (*b*) Power Smoothing, (*c*) Torsional Vibrations.

Under Inertia Forces general equations for the steady and unsteady forces and moments are developed as a number of power series in terms of the crank angle. The steady out-of-balance forces and moments for the single-cylinder engine are determined and means of eliminating or reducing them considered. The analysis is then repeated for multi-cylinder engines of the in-line, radial, vee, multi-row, rotary and other types, each engine configuration being treated with equal thoroughness. A short part of this section is devoted to a discussion of rotating balance weights. In order to clarify explanations, liberal use is made throughout the text of vectors without which a real understanding of the balancing problem is difficult. Results are illustrated in diagrammatic form and tables of dimensionless coefficients given to facilitate ease of calculation.

Four questions are considered under the term "power smoothing":—How large is the useful crankshaft torque derived from the cylinder gases? What forces arise in the engine elements due to the flow of energy? What size of energy reservoir is required? Is it necessary to account for friction forces? The power balance equation of the engine is quoted and each of the terms considered; the discussion of the friction losses being of particular interest. Methods of determining the flywheel inertia from a specified speed or angular deviation are considered in some detail for steady and unsteady engines and the problem of obtaining the speed or angular deviation for a system specified by other considerations is discussed. As in the previous section, the single-cylinder engine is treated first and the analyses extended to cover the various multi-cylinder engines.

In order to analyse the torsional vibrations of an engine, the real system must be replaced by an equivalent system. Two kinds of torsional deformation of the crankshaft are considered, torsion of the first kind, on which frequency calculations are normally based, being defined as that produced by torques applied to the ends of the shaft; the real torsion of the crankshaft caused by the forces acting on the connecting-rods and main bearings is defined as torsion of the second kind. The fundamental frequency is obtained with reasonable accuracy by considering torsion of the first kind, since any errors due to this approximation cancel out with those introduced by neglecting the effect of induced torsion. When higher overtones are considered, however, this convenient mutual cancellation does not occur. In the real engine when a torque is applied between two cranks, angular displacements are caused between all the cranks. These displacements, which are related to each other by experimentally determined influence coefficients, are classified as principal, primary induced, and secondary induced torsion. The effective moment of inertia of the moving parts is variable in the real engine. A mean value can be chosen for the equivalent system, but it is not obvious which intermediate value should be used. The value finally selected is only valid within certain definite limitations. Equations of motion for the real and equivalent systems are compared, the former being deduced from the general Lagrangian equations.

Recurrence formulæ are developed from which the natural frequencies of the equivalent system for an in-line engine can be determined. For the homogeneous engine, tabulated values of a defined frequency function are given for various values of a dimensionless frequency ratio, enabling all the natural frequencies of engines with up to eleven cylinders to be calculated with rapidity. These recurrence formulæ are then extended to include homogeneous engines with added rotating masses,

engines coupled in series and engines with split drives. Further modifications of the recurrence formulæ enable forced vibrations to be considered in order that crankshaft stresses may be determined. Finally the resonant and pseudo-resonant conditions are examined from a consideration of energy. Induced torsion effects as they appear in the real engine are analysed, the recurrence formulæ being suitably modified so that use can be made of the tabulated frequency functions. Variable moment of inertia is considered for small disturbances and it is shown that, at each critical speed, a critical range or doublet exists, the mean speed over the range corresponding to the value obtained by considering torsion of the first kind, as defined earlier, in conjunction with the most suitable value for the mean inertia. Two general methods are given for calculating the natural frequencies of the non-homogeneous engine system and this section concludes with a concise treatment of the pendulum vibration absorber.

Throughout the work the authors have set out to deal only with subject-matter in which they consider themselves able to advance some real contribution, and in this respect they have succeeded admirably. The treatment of the subject-matter is thorough, while the third section in particular contains many stimulating and interesting problems. Further reading is encouraged by the many useful references given to original work, the sources being exclusively German ; in this connection the authors have been somewhat introspective. One might question the view expressed in the preface that a problem is only worth solving if it is of practical application ; many examples can be quoted of problems pursued for academic interest which have at a later date proved of great practical use. Although some consideration has been given to approximations, increased emphasis might perhaps have been paid to the use of such methods, especially in cases where much detailed calculation may be avoided without an undue sacrifice in accuracy. However, to err in this direction rather than towards over simplification, is a good fault.

The British reader may find the notation confusing on the first reading ; this, however, should be no great deterrent. The mathematics is not difficult and many of the problems dealt with are clarified by numerical examples. It is possible that, to the post-graduate student, the book may prove to be of greater value as a source of reference rather than as a textbook for immediate study ; it will be, however, a valuable addition to the library of the research engineer, engine designer and all those concerned with the dynamics of the internal combustion engine.

*Dust is Dangerous.* By C. N. DAVIES. London : Faber and Faber, Ltd., 24, Russell Square, W.C.1. Price 21s.

THE subject of this book is very timely, in view of present interest in atmospheric impurities and the publication of the Beaver Committee Report. The scope is somewhat different from the general problem of "smog," being mainly concerned with those industrial dusts, other than the products of combustion, that constitute health hazards to the workers. The author is already well known for his researches on the physics of dust and the dynamics of particles. The present work is of a general descriptive character, free from mathematics and presented in a readable and simple manner.

Many papers on the physics of dust and dust control problems have been published in the journals of various societies during the last few years. The fundamental science of the subject is now well established, and the immediate need is the application of these principles to dust problems that occur in almost all industrial processes. In providing a summary of the health hazards produced by dust and in showing how fundamental principles may be applied in practice to eliminate these hazards the author has fulfilled a much-needed requirement.

The contents comprise a foreword by Sir George Barnett, H.M. Chief Inspector of Factories, and the early chapters discuss the physiological effects of dust inhalation by the industrial worker, dust sampling (which, it is not always realised, is a key problem upon which all subsequent researches depend), and methods of particle size measurement. Those sections are set out in simple manner, easily understood by those previously unfamiliar with the subject. Preventive measures, including the various methods of suppression and kinds of filters, are discussed fully, and the concluding chapters deal with radioactive dusts, house dusts, and dust explosions.

The photographs and photomicrographs are well reproduced. The book should be read by all concerned with the management of factories or works where dust problems occur. The title is apt, for dust is dangerous, but Dr. Davies has shown very clearly how this menace to human welfare may be mitigated.

*Metallurgy of the Non-Ferrous Metals.* By W. H. DENNIS. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 70s.

IT is a pleasure to welcome the appearance in England of a work fit to rival the American volumes which, for so many years, have dominated the field here explored, namely the recovery of the non-ferrous metals and the properties and uses of their important alloys. The primary appeal is to the extraction metallurgist, the emphasis being on the concentration of minerals, smelting of concentrates and refining of crude metal. To the engineer who is interested only in metals as structural materials it will be of little value. However, those who wish to acquaint themselves with the earlier stages of metal and alloy production, no matter whether they are qualified or still have student status, and who are anxious to acquire a reference book which is well written, adequately illustrated with clear diagrams, and up to date, may safely be advised to place this work on their shelves despite its cost.

The modernity of the book is one of its major attractions, references as recent as late 1953 being quoted. The selection of material from very diverse sources has been most competently performed. No serious criticism can be levelled on that score, although it could perhaps be said that no account of the lead blast-furnace is complete without description of the Port Pirie type with its double row of tuyeres (the only mention is in Table 38), and that in a discussion of the de-zincing of lead after the Parkes process, the Herculaneum practice of vacuum distillation, now adapted by Port Pirie to continuous operation, surely merits inclusion.

More serious defects, especially in a book of this price, are the presence of occasional misprints, obviously due to imperfect proof reading, instances of dubious usage of technical terms, e.g. a horizontal retort zinc furnace is described indiscriminately on page 23 as "recuperative" and "regenerative," and the appearance on page 194 of the rather peculiar statement that the main feature of the Sterling process of the New Jersey Zinc Company "is an electric arc furnace in which zinc reduction takes place by direct and indirect heat radiation from open arcs."

Such lapses are unfortunate and tend to throw discredit on a volume which genuinely represents a considerable achievement on the part of the author.

## SHORT NOTICES

*Formazione del Truciolo Metallico.* By F. A. Isnardi. Second revised edition. Milan : Ulrico Hoepli, Corso Matteoti, 12. Price 2600 lire (in Italian).—The main portion of Professor Isnardi's monograph on "Chip Formation in Metals" deals with the author's own extensive experiments concerning the effects of tool geometry and other factors, up to the end of 1953. The earlier 1941 edition has been substantially expanded as a result of the progress made in this field in the intervening years, and an introductory chapter on tool definitions and the relationships between tool angles has been added. Much of the confusion and lack of uniformity which still prevails with regard to the nomenclature of the subject is no doubt due to local differences which originated many years ago, but some of it reflects the conflict between scientific exactness and practical expediency. The system here described and used throughout is that of the Italian standard UNI 3401-3406 (originally prepared in 1942, but not published at the time owing to the war) and is similar to the German practice. Some notes on the Anglo-Saxon countries would, however, appear to apply to America rather than Great Britain. The historical section deals with experimental work from the early researches of Thime in the eighteen-seventies down to that of the last few years, in particular that of Tours on preheating in milling, and of Carro-Cao on plastic flow. A clear distinction is made throughout between "free" and "bound" formation of chips (Formazione Libera, Formazione Vincolata). The former is the case of chips flowing freely from a single cutting edge, the latter—the more usual case in practice—is that of a single edge consisting of two or more straight or curved portions, which gives rise to some crowding of the chips. The problem of plastic flow is further touched upon in the final chapter, which deals with some cutting tests of a plastic ceramic mass. The whole of the book is well illustrated with diagrams and photographs ; some misprints have, however, been noted, several of them in the bibliography, and it is hoped that there will be an opportunity for their correction.

## BOOKS RECEIVED

*Electrotechnique Générale.* By M. Denis-Papin. Paris : Dunod, 92, Rue Bonaparte (VI$^e$), Paris. Price 480F.

*Gas Journal, Calendar and Directory*, 1955. London : Walter King, Ltd., 11, Bolt Court, E.C.4. Price 25s.

*The Light Metals Handbook.* By G. A. Pagonis. London : Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 63s.

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## Pickling Shop for Large Steel Plates and Sections

DURING the past ten years a programme of reconstruction and re-equipment has been carried out in the Darlington works of Whessoe, Ltd., at a cost of £1,000,000. The scheme was recently completed with the placing in service of a new pickling and painting shop for mild steel plates and sections.

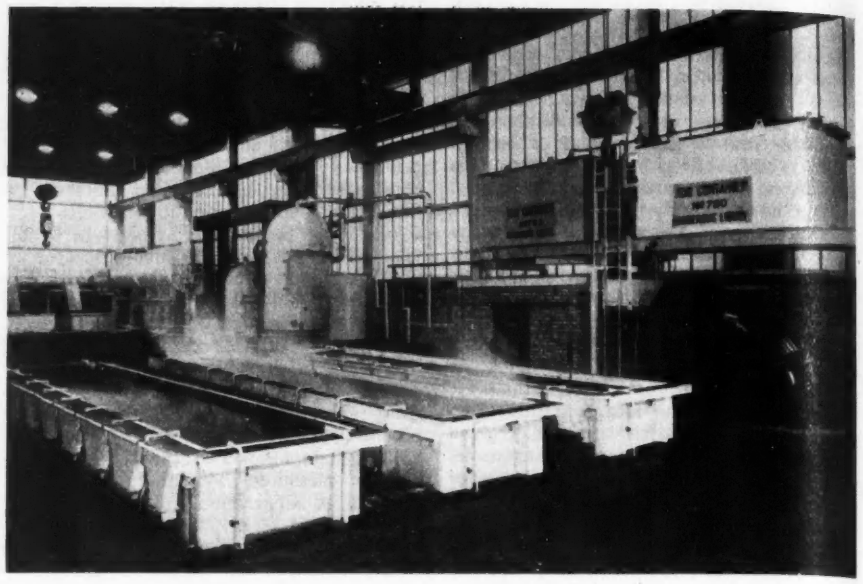
It is interesting to recall that this firm introduced the phosphoric acid pickling process in 1934, and in the process plates were first descaled in a hot 10–15 per cent solution of phosphoric acid followed by immersion in a 2 per cent solution at 85 deg. Cent. to form a thin corrosion inhibiting iron phosphate on the surface of the steel. Although this process gave satisfactory results it was expensive and in an effort to reduce costs the regeneration of the spent solution with sulphuric acid was tried for a time. Finally, as a result of joint investigation with the Shell Petroleum Company, the firm began in 1936 to use the sulphuric acid/phosphoric acid process which proved to be as effective as both of the previous processes as well as being cheaper.

In the process as now used millscale is removed in hot 5 per cent sulphuric acid and after the plate has then been washed in hot water it is finally immersed in 2 per cent phosphoric acid at 85 deg. Cent. The removal of millscale obviates the danger of accelerated corrosion and ensures that maximum life is obtained from a coat of priming paint applied before the steel has had time to cool appreciably. The phosphoric acid bath gives a film of iron phosphate, which inhibits under-paint corrosion and provides an excellent key for paint. The priming coat withstands rough handling during transport and erection of the steelwork and provides a good foundation for final painting.

The new shop is 400ft long, 62ft wide and 37ft high to the eaves and the pickling bath end can be seen in the photograph we reproduce herewith. It is of all-welded, rigid frame construction with brickwork cladding and has extensive glazing round the sides to provide good natural lighting. Four overhead travelling cranes, each of 7½ tons capacity, serve the full length of the shop.

The three pickling baths in the new shop are set in a pit lined with acid-resisting bricks. Each bath is about 33ft long, 5ft 9in wide and 9ft 6in deep, and their size will suit them for the larger sizes of plates coming into use. The baths are of mild steel construction with an acid-resisting rubber lining, and a further timber lining is fitted to protect the rubber from damage when plates are being introduced and removed. Steam for heating the baths is supplied by a vertical oil-fired boiler at the side of the shop. Acid storage tanks are also arranged along the side of the shop and an acid neutralising plant has been installed at one end.

Incoming material for treatment is stored in a large clear area at one end of the building and after passing through the pickling baths is transferred, whilst still hot, to a painting area immediately adjoining the baths. After painting, the sheets or sections are taken into a drying section from which they are afterwards moved into a bundling and packing section served by a dispatch loading bay.

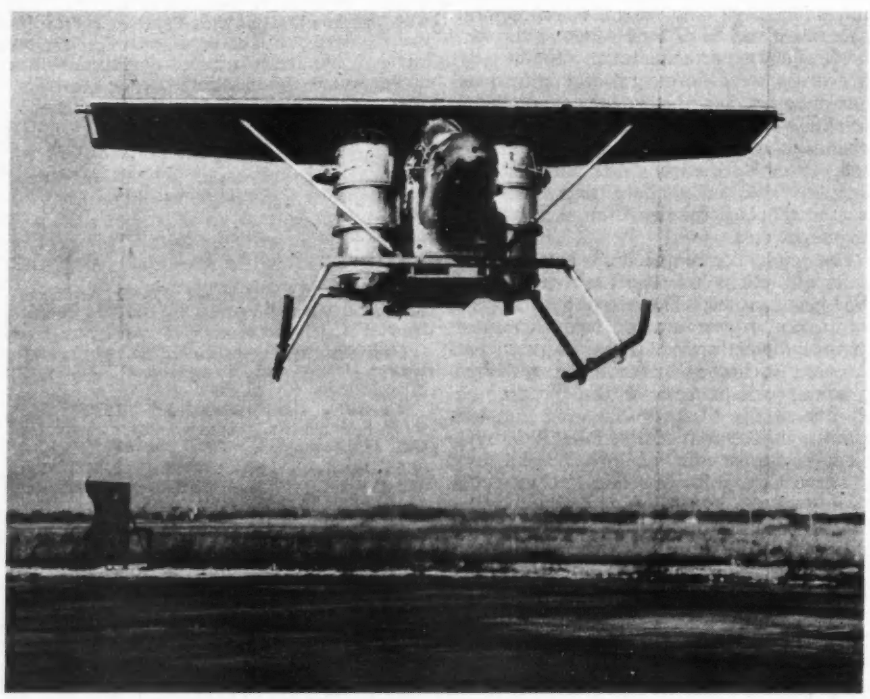


Pickling bath section of the new pickling and painting shop

## American Vertical-Take-Off Aircraft

IN the illustration below a more or less conventional wing and fuselage combination is shown hovering with no forward speed. It is supported by the reaction from two turbo-jet engines mounted vertically astride the fuselage and the various control moments are obtained by small compressed air jet outriggers. It will be seen, therefore, to have similar freedom of movement to that of the Rolls-Royce "Flying Bedstead," but in addition, once sufficient height has been obtained, the engines can be rotated into the horizontal position. The aircraft is then propelled and sustained in the conventional manner. As can be gathered from the illustration, the aircraft is purely an experimental rig on which to evaluate the engine mounting and pneumatic controls. It has a wing span of 26ft, a length of 21ft and weighs 2000 lb, and is made by the Bell Aircraft Company. The engines are Fairchild "J.4" turbo-jet units of 1000 lb static thrust. They are in the same auxiliary or short life engine category as the Rolls-Royce "Soar" turbo-jet engines. The "J.44" engine weighs 325 lb. It has a single-staged centrifugal compressor and turbine, an annular combustion chamber and it is mounted as a monocoque package unit.

With reference to the "Flying Bedstead," it has been pointed out by Rolls-Royce, Ltd., that the use of the vertical thrust engines to provide sustained forward propulsive thrust in level flight is not contemplated.



This aircraft, shown hovering, is supported by the thrust of two inverted turbo-jet engines. The airframe is largely conventional, but control is through compressed air jet outriggers. After climbing vertically the engines are rotated into the horizontal position for forward flight

## Proposed New London Underground Railway

A BRITISH TRANSPORT COMMISSION PRIVATE BILL introduced into Parliament this session, includes enabling powers for the construction of the first stage of a new London tube railway, Route "C." These powers are being sought to enable London Transport to complete its working plans and so be in a position to proceed with the construction of the new railway if and when a decision to carry out the scheme is reached. The proposed tube, which, if built, will be central London's first entirely new tube for nearly half a century, is one of those recommended by the London Plan Working Party set up by the British Transport Commission in 1948 to study the capital's rail transport problems. The length of this section of Route "C" would be just over 11 miles, with stations at the following points: Victoria, Green Park, Oxford Circus, Warren Street, Euston, King's Cross, Highbury, Finsbury Park, Seven Sisters, Tottenham Hale, Black Horse Road, Walthamstow High Street and Walthamstow Wood Street.

Except for a short section at the Walthamstow end, it would be entirely in tunnel, at depths mainly between 45ft and 60ft. The intention is to provide 12ft diameter tunnels to take standard tube type rolling stock.

The main objects of the line are to relieve congestion in the central area by giving an urgently-needed south-west/north-east link across the West End, to take account of the considerable commercial development in that area during the past fifty years; to relieve West End congestion generally; to give a direct Underground link between Victoria and the main line termini at King's Cross, St. Pancras and Euston; to give improved transport facilities for north-east London and to relieve congestion on the section of the Piccadilly Line between Finsbury Park and the West End (in effect the new tube will duplicate the Piccadilly Line between Finsbury Park and King's Cross as well as taking a more direct route to the West End) on which peak-hour overcrowding has been worse than any other comparable stretch of the Underground.

The new line would be fitted into the existing network in such a way as to give the maximum possibilities for interchange, in some cases by simple cross-platform interchange. Works at stations would include: new deep-level platforms and sub-surface ticket hall in the Southern Region forecourt at Victoria; and escalator interchange with District and Circle Line platforms; a subway interchange with Piccadilly Line at Green Park; the reconstruction of Oxford Circus Station on "Piccadilly Circus" lines, with cross-platform interchange with Bakerloo Line and subway interchange with the Central Line; the reconstruction of Euston Underground Station, to provide cross-platform interchange with Northern Line (City branch) and escalator interchange with Northern Line (West End branch) and main line terminus; the enlargement of the ticket hall at King's Cross with subway interchange with Northern and Piccadilly Lines, and escalator interchange with Metropolitan Line and with main line termini of St. Pancras and King's Cross and with street; the reconstruction of Highbury Station with new surface ticket hall and cross-platform interchange with Northern City Line; cross-platform interchange with Piccadilly Line at Finsbury Park and interchange with Eastern Region (Suburban service); a new sub-surface ticket hall beneath Tottenham High Road at Seven Sisters; new stations at Tottenham Hale, Black Horse Road and Walthamstow High Street; and enlargement of the Eastern Region surface station at Walthamstow Wood Street.

Plans at present provide for an initial peak-hour service of thirty-two trains an hour between Victoria and Seven Sisters, and sixteen per hour between Seven Sisters and Walthamstow. Provision would be made for peak-hour services on the in-town section to be stepped up to forty trains an hour if necessary later. Trains would be of seven cars in the peak hours, but stations would be planned to enable eight-car trains to operate if required. Victoria Station will be designed with the possible extension of the line to Fulham Broadway in mind.

## Helicopter Rescue Apparatus

DETAILS have been released of an apparatus to improve the means of rescue by helicopter which has been developed by the Royal Navy in the form of a scoop net. Since helicopters became air/sea rescue craft, the Navy's method of lifting persons from the sea has been by means of a strop which is lowered and then secured round the waist, either by the persons themselves or by an aircrewman lowered to assist them. Although existing methods of rescue normally work well, there are disadvantages. People struggling in the sea often cannot help themselves, and suspension in mid-air is frequently a completely new and terrifying experience. There is the added disadvantage that if a badly injured person is lifted by a strop further injury may be caused during the lift.

The scoop net consists simply of a rope net attached to a tubular frame which is in the form of a "D." The "D" frame is lowered face downwards into the water and is stabilised by a drogue. It is secured to a spacer bar by four cables and operated by a single cable from the helicopter's winch. The net is lowered into the sea as the aircraft is advancing at a speed of about 5 knots and a height of about 25ft. When in position for a pick-up the face of the "D" is submerged and the arc of the frame remains above water. It is then trawled through the water until the person is drawn into the net. The person can either be assisted into the aircraft or, if badly injured, allowed to remain undisturbed in the net until the helicopter returns to base.

**Helicopter about to "pick up" after trawling the drogue-stabilised "D" shaped net**

While the new method will not replace those methods already in use, it is considered that the scoop net is definitely the right approach to the problem of rescuing injured or unconscious people from the sea, but it will be impossible to use this method when there is wreckage near the person to be rescued.

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CORROSION RESISTANT FLOORS.—The latest of the Building Research Station's digests—No. 73—is concerned with corrosion resistant floors. Some of the principles of corrosion resistance that arise with reinforced concrete floors are outlined in the digest.

## Coalfields of Great Britain and Their Future Development*

By E. H. BROWNE, C.B.E., M.A.

IN this paper an attempt is made to survey the economic resources of the coalfields in the light of present knowledge, and to paint, with a broad brush, a picture of current plans and the possibilities of further development.

It might at first sight and in simple logic seem that any approach to a programme of development for the coal mining industry should be from a quantitative analysis of the total reserves available in the country. But, in fact, this is not a practical approach, and although various estimates of probable and possible coal reserves have been made from 1860 onwards, it is not thought that they have contributed, or that further attempts will contribute, to an assessment of the potential production of the mining industry, save in justifying the general conclusion that there is plenty of coal in the ground. The kernel of the problem is not total, but economic, reserves; and the governing, and interrelated factors are their accessibility, the possible rate of proving them and the possible rate of extracting them in each area.

For developments of individual collieries, detailed quantitative estimates of coal reserves have to be worked out and closely studied. But for a general assessment of the development of the industry, it is of little avail to divide broad overall estimates of total reserves by assumed annual outputs so as to arrive at forecasts in terms of life: the approach must be from the other end, by studying possibilities of development and aggregating potential outputs. However great the reserves of coal in total, the prospects of obtaining and maintaining a high productive level are governed by the availability of other forms of resources—human and financial—which must be taken fully into account. The level of production hinges primarily on capacity to produce and not on total reserves.

For the future, two things stand out; first, that most output must, as far as can be foreseen, come from areas already explored, many of them much worked in the past, and, secondly, that very much of the best coal and the coal which is easiest and cheapest to get has gone.

There are some new areas or extensions of fields now worked which have not yet been exploited and where new collieries are being sunk or planned. Others suggest themselves for early development, but need more proving to determine the structure of the strata and the economic possibilities of working. Yet others need more proving before even a provisional estimate of them can be made, and this proving must be progressive, one borehole often determining the site of the next as geological obscurity is removed in stages and the general structure of the field is deduced. Some regions are fairly well understood but do not appear attractive enough to justify development. And there are the more speculative areas where it is known, or at least assumed with some confidence, that coal exists, but where the nature of its occurrence, the condition of the seams and the strata in which they are situated are more or less unknown. Finally, there is the possibility of fields hitherto altogether unknown. The carboniferous rocks were laid down over an area divided by a land barrier across the Midlands. The only coalfields so far proved south of that barrier are those of South Wales, the Forest of Dean, Somerset and Kent, but there is every possibility that areas of coal-bearing rocks are present in the region between them. Great thicknesses of rocks were deposited after the carboniferous period, but there may be places where the coal measures lie no deeper than in Kent, and where the seams are therefore workable.

But taking all these into account—the hard facts and the most nebulous inferences—we are left with a clear contrast between the position in the middle of the twentieth century and that of the great expanding period of British coal mining from the 1870's to 1913. The easiest, most accessible, coal was then available. Most of it has now gone and we are slowly but steadily increasing the average depth of our workings. Thus, the shaft winding depths of all the new

* Paper presented to the Institution of Mining Engineers, January 27th. Abridged.

collieries authorised since the end of 1946 are in the range of 600 to 1000 yards, whereas about 80 per cent of present output is got from shafts less than 600 yards deep.

Because so much of the easiest won coal has gone and mining difficulties generally are ever slowly increasing, new techniques for coal extraction must be developed to meet the higher costs of working ; new layouts must be evolved to make the transport and services more efficient ; new methods of preparation must be used to make coal from the less good seams suitable for the markets.

The increasing use of alternative fuels does not necessarily mean a decline in the demand for coal. Consumption is rising, and there is no reason to suppose that it will not go on rising. If it does, it seems reasonable to assume that greater consumption of oil—and even the development of atomic energy—will in the main be absorbed by increased use of power, and that the demand for coal will be maintained. That is why the National Coal Board are aiming for productive capacity of up to 250 million tons per annum, though no one suggests that there can be precision in a forecast of this kind. There will be great difficulty in attaining and maintaining such a level of output.

We cannot, of course, think in terms of total tonnage only : extremely important are the kinds of coal, and the location of production in relation to the points of usage. In planning of this kind, a far-reaching examination must be made of the relative potentialities of the various coalfields and there must be an attempt to relate these to the future distribution of demand, taking into account the charges for transport of coal as well as the costs of production.

Theoretically, if we were to assume unlimited labour and unlimited costs, unlimited calls on the engineering resources of the country and an unlimited trained staff in the mining industry capable of exploiting all these, there would be hardly any limit to our capacity to produce coal. But in practice we cannot assume unlimited labour, nor can we disregard costs, and there are other limitations. At a time when the industry is failing to meet demand the emphasis will tend always to fall mainly on output and the capacity to produce it ; but in the long run the most important problem of all will be to obtain efficiency in production and to get coal at costs which do not place an excessive strain on the resources of the country as a whole.

To-day, average costs of coal production mask elements of extremely high cost tonnage. Under public ownership the industry, paradoxically, has to carry heavy losses through not being able to reduce output. It is necessary to provide new capacity to eliminate the worst of this " marginal " tonnage. It is necessary also to provide new capacity to increase output, and above all to replace the wastage of capacity which is going on swiftly—to make up for the drain on the mining industry which occurred in the years of depression and the war, and to do this at a time when access to new coal areas takes much longer to gain and is much more costly than it was in the past.

In making any general appraisal of the British coalfields stress must be laid on the extraordinarily wide range of geological conditions in them. These differences in natural conditions between one coalfield and another combine to cause great disparities in the costs of production, disparities which have grown much more important over the last fifteen years or so. There are also important differences in the variety or rank of coal, and in its quality in terms of ash and moisture, which have a big effect on the commercial value of the fuels produced and which help in some cases to balance the advantages or disadvantages of natural conditions. The disparity between the costs of production in different parts of the country is extremely relevant to considerations of future development.

There is, of course, much to be done to improve efficiency in mining, and a desperate need for the modernisation of the collieries which is proceeding under the plan for reconstructing the industry, and the more difficult coalfields—which suffered and still suffer greatly from the effects of contraction and depression between the wars—have huge opportunities for improvements in costs. These will come by reconstruction, by improving techniques generally, and by the elimination of those collieries which have become exhausted or are depleted of economic reserves. But several factors will tend to reinforce the disadvantages and advantages of natural conditions. New methods and machines will find success more easily in the easier coalfields (where productivity is generally already the highest). For this and other reasons it is believed that the economic effect of differences in mining conditions will remain and become even more marked as time goes on.

The pattern of coal production in the country to-day has been formed by economic influences which have long since changed. It is out of date in the sense that coal is produced uneconomically —taking into account costs of delivery as well as costs of production—from some places, whereas high rates of profit can be earned elsewhere. There are historical causes of this : in times past, particularly when the easiest coal was there to be got, the difference in cost between the highly productive regions and those where output per manshift was low was offset, or sometimes amply covered, by the costs of transporting coal to the points of usage. In short, the " geographical " advantage of the coalfield was the predominant factor. As time has gone on, the easiest coal has been worked in the older fields : mining has become more difficult with deeper workings and the necessity to extract seams which, in one way or another, are less attractive in themselves or which lie at greater depths or in more highly disturbed regions. These are the general influences which are bound to operate in an extractive industry and which will be felt increasingly throughout the country. It is understandable that they have been felt first in the oldest coalfields where either resources have been limited in total or, owing to the relatively steep general gradients of the strata, extensions advanced to greater depth more quickly than in the flatter fields. The geographical position of the fields is still important in its bearing on transport cost, and physical limitations to the carriage of coal to some degree override questions of cost—for instance, in the case of consumers who can now receive coal only by ship. Nevertheless, a shift in the pattern of production is necessary on economic grounds, and it is governed by the availability of economic reserves for the future.

The differences in the kinds of coal available are extremely important in their effect on development programmes. Generalisations about these differences are bound to be over-simplified and approximate. For instance, rank varies with depth, but not consistently, so that in one place coal of several distinct types may be present, and coalfields which produce coals mostly of only one type, or one range of quality, often have individual seams of other types and nearly always of widely varying ash content.

The demand for carbonisation coals must be expected to increase, and it is therefore peculiarly ironic that our main reserves—in the East Midlands, the easterly extension of the Yorkshire coalfield, the West Midlands, and the best areas of Scotland—are largely of low rank and are not attractive for carbonisation purposes with present techniques. The demands of the steel industry for coking coal, and of gas works for gas coal—with their overlapping specifications—become, therefore, one of the main problems for the future.

Unless new techniques change the whole picture, it will be hard to meet the demand for true coking coals and they must be eked out by the maximum use of lower rank coals, of which there will be substantial tonnages of suitable specification in ash and sulphur. It means that these coals must be reserved for the purposes for which they are specially suitable and the qualitative advantages of carbonisation coals must in the future—in contrast to the past—predominate over geographical advantage. New developments in making smokeless fuels should aim to use the lower rank coals and not the carbonisation coals. It means, too, that in the programme of development, we must pay special regard to the exploitation of reserves of carbonisation coals, expecting that they will be able to carry heavier costs of production than the " general " low rank coals which are so attractive to the mining engineer owing to the generally more favourable natural conditions in which they occur.

[The author of the paper then went on to deal with the individual coalfields in Great Britain, areas for new development, and possible new coalfields.]

What are the conclusions to be drawn from this rapid survey of the coalfields of Great Britain and appreciation of their future development ?

The first thing which emerges is that there are large total reserves of coal lying under the island and within accessible coastal regions under the sea.

The limits of coal production are, however, governed by three things—all interrelated in their effect ; the physical capacity of the collieries, the manpower available, and the costs of production. We must have the access to the coals and the means of working them, but very low levels of productivity mean excessive cost and the extravagant use of manpower. Expansion of productive capacity is a formidable task, which grows progressively harder with the exhaustion of the easier got reserves.

New developments are deeper and in general more difficult : in regions where much of the coal has already been extracted the advantages of having the structure of the field proved are usually far outweighed by having had the larder previously raided. Our traditional system of single-seam working, though it remains right where the measures are not steeply inclined and the strata are generally undisturbed, has created great problems in some parts of the country where costly developments are necessary to get the remaining coals. To some extent haphazard or extravagant working of the best and most accessible coal reserves in the past has not only led to the waste of substantial resources, which have been spoiled for future working, but has intensified the problems of working other coals in the same areas.

We need, and are trying to bring about, a renaissance in the mining industry. This involves many things—improved techniques, methods and mechanisation of the basic processes of extracting the coal ; new standards of technical management and the use of better methods and instruments of managerial control ; better technical services ; better systems of training for all levels in the industry, and, perhaps above all, better labour relations. We need, too, a vast programme of reconstruction and development which cannot wait until the resources of the industry are in good shape for it ; this must be pressed on with the highest degree of urgency if we are to arrest and reverse the long-persisting trends of decline.

The pattern of production from the various coalfields must change to meet changed circumstances. This is inevitable, but it provides the opportunity for deliberate and rational development of the coal resources of the country. It is for mining engineers to use this opportunity wisely and well.

## Technical Report

*The Dielectric Properties of Silicone Liquids and Greases—III* (Ref. L/T296). By E. Rushton and J. V. L. Parry. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 7s. 6d., postage 3d.—The dielectric properties of silicone liquids of viscosity from 12,500 to 200,000 centistokes have been studied over a frequency range of 60 c/s to 24,000 Mc/s. The results confirm the findings of previous reports (L/T201 and L/T247) that from the point of view of dielectric properties the silicone liquids fall into two classes : the first class comprising the liquids of low viscosity, and the second class the high viscosity liquids (from 20 centistokes upwards). The two classes have different dielectric properties, but their behaviour can be explained in terms of a single relaxation time, which appears to be a characteristic of the silicon-oxygen linkage in the linear structure. The greases resemble in dielectric properties the second class of liquids, but they appear to be characterised by a broad distribution of relaxation times rather than a sharply defined value, and their behaviour at low frequencies shows evidence of conduction arising from ionic impurities.

# Propeller Turbines and Civil Airframes

ONE of the most heartening events for the British aircraft industry since the war was the sudden acceptance in the United States of the superiority of the propeller turbine civil aircraft. Following the appearance of the Vickers "Viscount" into its own skies, America now embraces this concept with such ardour that according to all reports it is at this moment scrambling to convert most of its first line twin and four-engine airliners and to expedite existing new turbo-propeller projects. America finds, however, that it has no turbo-propeller engines sufficiently developed in the required power ranges with which to effect this conversion. Consequently, there arises the intriguing situation in which America, on the one hand, has a number of highly developed airframes which might be fairly quickly convertible, but has no engines, and Great Britain with at least one reputable engine in each of three most suitable power categories, but having many fewer airframes to convert. Considering entirely new aircraft it is to Britain's credit that one medium-range airliner has been established already and one long-range aircraft is at an advanced stage of development. Ideally, an aircraft is likely to be more successful designed around its power plant than one adapted to suit. A converted piston machine, for instance, may need to compromise either fuel consumption or passenger comfort because of cabin pressurisation restrictions. It follows that if, for instance, the "Britannia" proves successful, it should be superior to converted American machines in the same category, which may well have British engines. Supposing then, as is likely, that machines in both categories become available together. The immediate issue confronting the airline operators, and which is now wide open, becomes that of deciding whether it is cheaper or more discreet to combine a proven American airframe with a British engine in a slightly imperfect marriage or of accepting the greater risk involved with an entirely new airframe to obtain the most ideal alliance.

As far as the British engine industry is concerned, circumstances could not be more favourable, and we have recently had the opportunity of hearing the present situation discussed by The Bristol Aeroplane Co. Ltd.,* Rolls-Royce, Ltd., and Napier and Son, Ltd. These companies have made intensive investigations of the trends now taking shape in American policy and opinion. They were convinced that America intends to convert to propeller turbine engines and that their need for British engines made here or under licence is a real one.

This revolutionary advance in civil aircraft propulsion has been largely effected by one engine —the Rolls-Royce "Dart." In a representative airframe the operational and mechanical advantages of using the prime mover, together with the superior economy in operation, were largely predictable. What was not predictable —and upon this more than anything else the prospects of gas turbine propulsion had hinged—were the factors of engine life, reliability and safety. Unfortunately, there has been so far little military interest in this prime mover and the task of assessing these aspects of it have had to be undertaken entirely by the engine manufacturers and in the first case by one airline, British European Airways. As is now well known, the "Dart" has acquitted itself almost unconditionally in all these considerations. More important than its own individual success, however, is the fact that it justifies faith throughout the world in the gas turbine as a prime mover and very materially enhances British engineering prestige in this field.

What the development of the "Dart" gas turbine has involved is perhaps best illustrated by some figures given by Rolls-Royce, Ltd. Its entry into service in 1953 was preceded by eight years' development during which time some 15,000 hours' development running was logged. It has since completed an additional 21,000 hours' development running with altogether 16,000 hours' flight development. Since its entry into airline service some 210,000 flying hours have been logged.

It is generally regarded that the extent of the Rolls-Royce gas turbine research facilities has no equal in America. There, development of the turbo-propeller engine for civil applications has been lethargic—an attitude which this country did nothing to disturb! It is therefore unlikely that the lead which Rolls-Royce in particular has clearly established can be seriously challenged in the near future, either in design or production.

The company is well aware that the "Dart" is largely out of date when compared with more recent specifications, and it has already announced the existence of a new "RB 109" engine of very advanced design.

The "Dart" engine, it may be recalled, was rather modestly loaded, both thermally and dynamically, employed centrifugal compression, and it was in a particularly low power output class in spite of the fact that it had gradually developed from 1000 e.s.h.p. up to 1695 e.s.h.p. We were shown a stripped "Dart" engine after it had completed a service life of 1514 hours, which included 815 hours after a first overhaul. The only parts which were considered to have deteriorated were the combustion cans and the nozzle guide vanes. The life of the cans has hitherto been 422 hours, their characteristic failure being due to differential thermal stresses. Improved distribution of the secondary air around the inner can has now very greatly increased the can life. With the nozzle guide vanes slight cracking occurred and their life has been prolonged by altering the pitch spacing, which has reduced the vane temperature. Other past modifications have included the use of polished compressor guide vanes and a helical low-speed gear train.

The company's "R.B.109" of which only a wooden mock-up has been shown, is nominally rated at 4000 s.h.p. and 1000 lb thrust, and its design quite obviously bears no relation to the "Dart." In all probability the design is likely to incorporate much of the later "Avon" layout. It can be deduced from the very small diameter of the unit that high pressures and consequently high temperatures have been employed, but whether blade cooling has been resorted to cannot be disclosed. The engine does not operate on a constant power/altitude cycle but the actual shaft layout chosen is also secret.

As a measure of the efficiency of the advanced thermal and mechanical system employed the company spoke of a fuel consumption better than the American turbo-compounded petrol engines, i.e. 0·38 lb/s.h.p./hour.

As regards its production plans of the "Dart" engine, Rolls-Royce, Ltd. stated that they had many earnest and urgent requests in America for Derby-made engines. The company had, however, reserved its entire output for the Vickers "Viscount" for the next three years.

It is in the power bracket that Rolls-Royce, Ltd., has ignored, i.e. 3000 s.h.p. to 4000 s.h.p., that Napier and Son, Ltd., believes to be a most important one in the immediate future. The Napier "Eland" which is now going into production, is an engine in this category. In speaking of the company's commercial policy the company mentioned that the outlets for the British manufacturer of turbo-propeller engines in the home market were limited. It maintained that the lack of adequate finance for transport aircraft for the Armed Services was mainly responsible. A contributory cause was the difficulty which a new entrant to the turbo-propeller field inevitably has when confronted by the old-established and well-defined airframe and engine manufacturer partnerships. The only alternative was to enter the export market by way of direct sales or licensing. Moreover, the establishment of any new British engine in markets and in service overseas, paved the way for British aircraft constructors to introduce new designs of their own, making use of that engine, at a later stage.

The company believed that when America became obliged to recognise the gas turbine it was likely she would need to resort to converting existing airframes to this prime mover during a transitory period. It was in anticipation of such an event that the company chose an engine which could be most economically fitted to existing American twin and four-engined airliners. Discussions with American users had also convinced the company of the importance of retaining a simple single shaft engine utilising high component efficiencies.

In pursuance of this policy the company has taken the step of purchasing an American "Convair 340" airliner. With this it intends to fit the "Eland," obtain a Certificate of Airworthiness and demonstrate the aircraft in America. The pay load and range of the "Convair 340" are increased with the "Eland" engine and a speed increase of about 60 m.p.h. is achieved.

This step was taken to demonstrate the "Eland" in an aircraft in current production (no suitable British airframe being available), to help to build up flying hours rapidly, and to provide a satisfactory test vehicle for the 4200 e.h.p. "Eland" in due course, for which, again, no suitable British type is available.

This Government-sponsored "Eland" engine first ran in September, 1952; it began its flight trials in July, 1954, and just before Christmas it successfully completed, at the first attempt, a 150-hour rehearsal type test at its full initial rating.

The Napier practice of engine development has been to develop and test each major component individually (reduction gear, compressor, turbine, &c.). In this way, the company states, the risk of delays due to component failure when engines come to be tested as complete units has been minimised. This practice has an added advantage in that development running requires fewer engines. The "Eland" has reached the type test stage with only seven engines built. These engines between them have so far run over 2000 hours on the bench and over 100 hours in a "Varsity" aircraft—two of them have totalled 1200 hours and the company maintains that the inherent reliability of the engine has been established. In addition, there have been several thousand hours of component running.

The present rating of the "Eland" is 3000/3250 e.h.p. A programme for increasing this rating has been in hand for some time and a 4000/4200 e.h.p. version is now on development. The added power is derived from the use of a higher compression ratio and a cooled turbine designed to operate at higher inlet temperatures. Otherwise the two marks of engine are fundamentally the same with a proved compressor, a proved combustion system and a reduction gear which has already been type tested under 4000 e.h.p. conditions.

The Napier company's faith in the "Eland" is demonstrated by the decision taken last year to put in hand the manufacture of engines as a private venture. These engines will be coming off the production line during 1955 and will be available for flying in prototype aircraft. Considerable tooling has been set up for their manufacture, so that production against orders can be expanded quickly as from January, 1956.

Apart from the purchase of a "Convair-Liner 340," the company is also to convert an "Elizabethan" aircraft.

With the "Varsity" already flying under Ministry of Supply sponsorship and the pre-production "Elizabethan" and the "Convair 340" due to be converted by July, it is hoped to accumulate a considerable number of "Eland" hours in the air by the end of 1955. The next stage will be to gain actual airline operating experience with the two airliners as soon as Certificates of Airworthiness have been obtained. B.E.A. are keenly interested in the fitting of the "Elizabethan" prototype with "Eland" engines. It is planned to make the "Convair 340" available for world-wide demonstration and arrangements are already being made to dispatch the aircraft to the U.S.A. for intensive trials with one of the domestic operators. The company is already working closely with the Civil Aero-

* See THE ENGINEER, February 4th

nautics Authority with the object of reducing the time eventually required to obtain American certification for the engine.

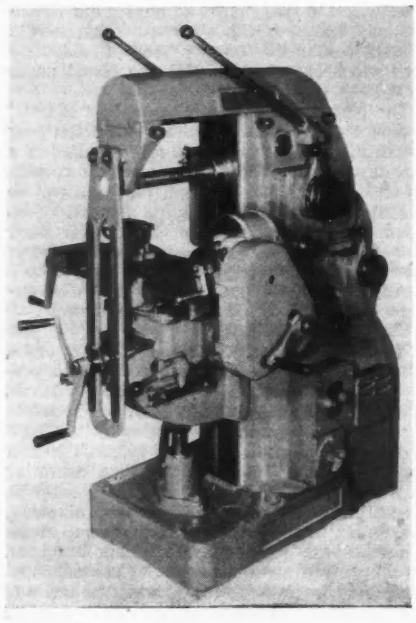
This is the company's immediate programme and thereafter the 3000/3250 e.h.p. "Eland" will be in quantity production from the beginning of 1956 and the 4200 e.h.p. "Eland" some eighteen months later. Much of the experience gained will be in common to both engines. The "Eland" has a single lever control system which is entirely mechanical in operation, providing standards of flexibility and safety which the company maintains has considerably impressed American anthorities. The "Eland" has a lower specific weight (0·52 lb per horsepower) than any other turbo-propeller engine of which details have been released. It has also one of the lowest specific fuel consumptions (0·49 lb/e.s.h.p./hour cruising). It is perhaps worth recalling that this company also produced a piston engine the "Sabre," which had a specific weight considerably lower than that of any other piston engine (0·73 lb per horsepower), and it developed 95·4 h.p. per litre, as against 60/70 h.p. per litre characteristic of all other piston engines in the 3000/4000 h.p. category.

## Geared Universal Milling Machine

An all-geared plain and an all-geared universal milling machine are now being made by Midgley and Sutcliffe, Ltd., of Hillidge Works, Hunslet, Leeds, and one of the universal models is illustrated below.

This new machine has a hardened and ground alloy steel spindle bored to No. 40 National Steel taper and carrying a 1in diameter cutter arbor. This spindle is mounted on Timken taper roller bearings at the front and a roller bearing at the back. Twelve spindle speeds, ranging from 30 to 700 r.p.m. in geometrical progression, are provided, changes being easily made through sliding gears mounted on splined shafts. Twelve feeds which are available, independent of the spindle speeds, range from ¼in to 12in per minute and, like the speeds, these changes are made through sliding gears mounted on ground splined shafts carried on ball bearings. Both the speed and the feed changes are controlled through a lever and disc, the operating speed and feed being indicated on a direct reading dial.

All the gearing and ball races of the shafts are adequately lubricated by oil fed from a mechanical pump fitted inside the body. The oil is pumped up to the top of the body and allowed to cascade freely, a tell-tale sight glass being provided to indicate whether the oil is flowing correctly. A gear suds pump enclosed in the body is provided for supplying coolant to the cutters.



All-geared universal milling machine with a 1in diameter cutter arbor

The machine is driven by a 2 h.p. motor running at 1450 r.p.m. This motor is fitted to a hinged base plate and housed inside the machine body, provision being made for tensioning the four vee belts which drive the pulley shaft. Control is through a double disc friction clutch, one side of which forms a brake for the spindle. The clutch is operated by a pair of levers at the top of the machine and the motor is started and stopped by a push-button switch mounted at the side of the machine immediately above an isolating switch.

The deep section table has three tee slots and a working surface of 30in by 8in, and can be swivelled 45 deg. on each side of the centre line. The longitudinal traverse of 18in and cross traverse of 6in are arranged for hand or automatic operation and there is a vertical hand-operated adjustment of 6in. The universal machine, as illustrated, is fitted as a standard with one of the firm's universal dividing heads.

## Wire Rope Parting Machine

An improved design of wire rope parting machine introduced recently by the Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17, is illustrated below. The machine, in addition to sealing and tapering the ends of wire ropes (as shown in the lower part of Fig. 2), can be used to seal each individual strand on ropes which are to be spliced afterwards. Ropes with the ends sealed in this way, instead of being bound, are easier to thread and are less liable to cause injury when being handled.

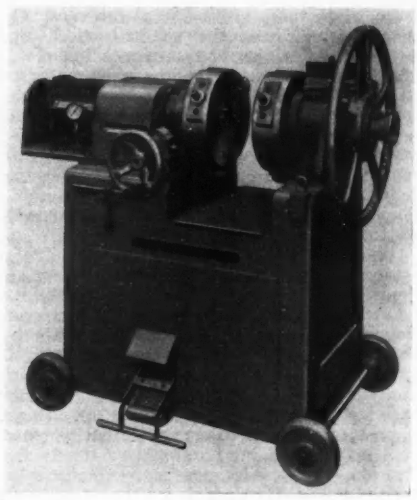


Fig. 1—Wire rope parting machine for producing sealed and tapered conical ends or sealing the ends of individual strands ready for splicing

One of the improvements on the new Metrovick machine is a hydraulic mechanism for applying tension to the rope during parting. This replaces the original handwheel operated tensioning gear and reduces the amount of effort required by the operator. The machine can be used for continuous operation in parting either steel or hemp-cored wire ropes from ⅜in up to 1in diameter, or occasionally up to 1¼in diameter.

The machine has two clamping heads, each of which is fitted with two preset jaws and one clamping jaw to enable different diameters of wire rope to be accommodated. The right-hand head can be turned in its bearings and is operated directly by a large diameter handwheel. The left-hand head is slid along in its bearings to stretch the rope by two small hydraulic cylinders, one cylinder being on each side to give a balanced pull. These cylinders are coupled to a small hand-operated gear pump mounted at the left-hand side of the machine and a small header tank is provided at the rear to make good any leakage which may occur. To enable the rope to be placed in position without threading through the machine both clamping heads are slotted along the top, so that the rope can be dropped into position.

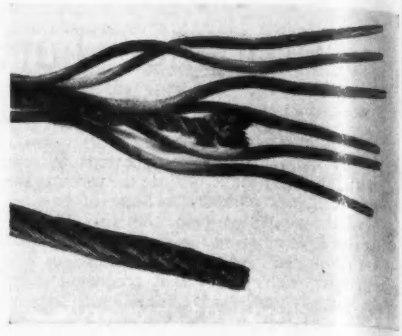


Fig. 2—Sealed and tapered wire rope and an unwound rope with its strands sealed ready for splicing, as produced on parting machine

Each clamp is connected to the secondary winding of a 25kVA air cooled transformer mounted within the machine framework. This transformer supplies the low voltage heating current and is controlled through a contactor by a foot switch at the front of the machine. A tap changer with two control plugs gives the choice of eight heating speeds.

To operate the machine the rope is dropped into place with the required point of parting midway between the heads. It is then clamped securely and if a complete seal is required the rope is twisted by the right-hand head to tighten the lay; about one turn normally being required. The foot switch is then depressed and as the rope heats up the left-hand head is retracted by the hydraulic cylinders. By manipulating the heat and the tension, the rope can be drawn down in the centre to give any required degree of taper. After a definite neck has appeared no further tension need be applied and continued application of the current causes the rope to burn through and the wires to fuse together, leaving a welded conical tip to the rope.

If it is desired to splice the end of the rope after parting, instead of tightening the lay it is unwound until all the strands lie parallel to each other in the gap of the machine, and heat and tension are then applied in the same way. According to the makers, a ⅜in diameter wire rope can be parted in fifty seconds, and a 1¼in diameter rope in 120 seconds.

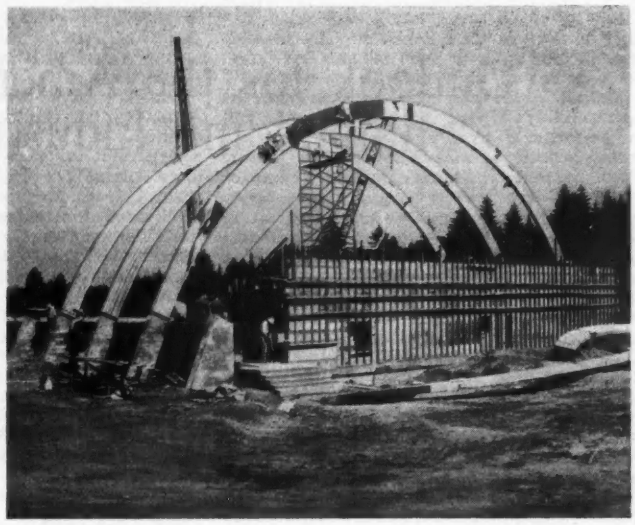
## Laminated Timber Construction in Canada

BY OUR CANADIAN CORRESPONDENT

Several of the buildings of the South Bank Exhibition of the 1951 Festival of Britain were constructed with glued and laminated timber structural elements; to-day, the arches of the air terminal at Waterloo may still be seen as an example of this method of construction. Its increased use in Canada is indicated by the completion of two buildings in British Columbia. The first, which was opened to the public during the Pacific National Exhibition, was the 1,400,000 dollar British Columbia Building, which is a structure covering 262,000 square feet. The centre section of the building, with three levels, houses a 60ft by 70ft relief map of British Columbia (which itself took seven years to construct), and is roofed by a glass dome supported by eight formed glued laminated arches, resting on four steel trusses. The two side sections are wings to the centre section, with two levels, a complete reinforced concrete semi-basement covering the entire ground area. Inclined planes take the place of stairs to help in the handling of the heavy exhibits which this building will display.

The Commonwealth Construction Company, of Vancouver, erected the building, which combined the use of a total of 537 glued laminated beams, ranging from 6in by 10in to 12in by 36in, with ten precast concrete beams of 12in by 36in, and twelve hundred 4in by 12in precast concrete joists. The laminated beams and arches,

Lower floor of the British Columbia building, showing timber construction



Three glued-laminated arches in position during construction of a gymnasium in Vancouver

supplied by American Fabricators, Ltd., Burnaby, B.C., were prefabricated. The laminations were horizontal and, in the case of the beams, they were cambered. The interior structure displays the finished laminated beams, which are supported on tubular columns ranging in sizes of 4in, 5in and 6in, surmounted by channel shoe plates upon which the beams rest and to which they are bolted with ⅝in bolts. For the wall support of the beams the channel shoe plates are inserted into the concrete with 2in of the ends of the beams projecting into the concrete, the beams being bolted to the hangers. The ends projecting into the concrete were treated with " Cuprinol " and wrapped in heavy roofing felt before hanging.

In the hanging of the purlins an inverted " V " hanger was used, with a 3in ledge for a purlin at each side. The end of a 6in by 12in purlin rests on each 3in ledge and projects 2½in above the hanger, where the two abutting purlin ends are tied with 2in by 2in strips nailed across the top of the hanger and beam. This open support gives the interior a not unpleasant appearance with great simplicity. The exterior finish of the building has vertical wood walling. No windows are set in the wall surface, there being skylights. The utilisation of local woods provided an economical building material, we are informed, and one with which the architects and engineers were well versed. The architects were Sharp, Thompson, Berwick and Pratt, of Vancouver, and the structural engineer was Victor Thorson, P.Eng.

The second building, mentioned earlier, is the gymnasium and buildings of the University Hill High School, in the Point Grey area of Greater Vancouver, where three-pinned " Glu-Lam " wood arches, 9in by 32½in section, were erected. The radius of the arch is 54ft 2½in, the centre of the circle being approximately 15ft below ground level. The bases of each arch were set on a buttress of reinforced concrete, 16in by 32½in, inclined to the line of thrust. The springing of the timber arch is bolted to the buttress, with two steel angles, one fixed along each " long " side of the arch to take the bolts, and with a layer of heavy building paper forming the hinge. The top hinge is similar, with two steel coupling pieces connected by a 1½in pin. As can be seen from the accompanying illustration, the two cranes handle the arches, the top hinge fixing being accomplished from a movable scaffold.

The weight of each half arch is about 5000 lb. Six complete laminated arches are at present the extent of the construction of the gymnasium, giving five bays of 15ft each.

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J. S. Owens Essay Competition.—The Royal Sanitary Institute is to make an award of £50 for a prize-winning essay on " The Problem of Engine Exhaust Fumes from Road Vehicles " in connection with this year's John S. Owens competition. Full details can be obtained from the Secretary of the Royal Sanitary Institute, 90, Buckingham Palace Road, London, S.W.1.

## African Engineering News

BY OUR SOUTH AFRICAN CORRESPONDENT

### Rhodesian Rail Link with Lourenco Marques

Work on the Portuguese Government's railway line which will link Southern Rhodesia with the coast at Lourenço Marques is reported to be well ahead of schedule. The line, started in 1952, will link Bannockburn in Southern Rhodesia with Guija, on the line that joins the Pretoria-Lourenço Marques Railway. Most of the total earthworks for the line have now been completed, all culverts and bridges are finished, and about 65 miles of track has already been laid and ballasted. The four stations along the Rhodesian section of the line have not yet been started, but they have been sited and work is expected to begin fairly soon.

A temporary bridge across the Limpopo, 119 small bridges and culverts, and one of five stations have been completed. Many of the 341 houses required along the line are ready for occupation and others are nearing completion. Tracklaying has been completed from Bannockburn to a point some 40 miles from Rutanga, where the rail crosses the Fort Victoria-Beit Bridge road. Rutanga itself has now become the headquarters of the construction teams. The line is to be open for traffic by the end of 1955. The estimated total cost of the new line is £8,750,000. With the Beira line and the new line Portuguese East Africa is expected to be able to meet all traffic requirements under the best economical conditions for many years to come.

### South African Road Bridge

A single-span bridge is being built over the Storms River gorge between Knysna and Humansdorp. When the bridge is completed in 1956 the coastal road will be shortened by 10 miles. The height from river bed to road level will be about 400ft. The Storms River gorge is a precipitous trough presenting a difficult site for the erection of a bridge. The arch girder span of the bridge will be built in two halves, which will eventually be lowered into position, giving a span of 330ft with a rise of 66ft in the centre. The roadway will be built above the arch girder, the completed structure being 628ft long with a roadway 22ft wide and two footpaths, each 2ft wide. It is estimated that the total cost of the bridge will be £96,000.

### Plan for Dam in Basutoland

The Basutoland Government is now making a final survey for a £10,000,000 dam and hydro-electric project near the source of the Orange River. The dam and power station will be at an altitude of 8000ft, in the Sekakes-Seforong district, 12 miles from the Orange River catchment area. The site of the dam wall is a narrow defile and the reservoir will be more than 90 miles long with natural sides formed by the steep banks. It will take eight years to fill. As the site is in a remote mountainous area, an airstrip is envisaged for the use of engineers and technicians.

### Projected Sulphuric Acid Plant for Blyvoor Mine

It is stated that investigations into the question of erecting a plant on the property of the Blyvooruitzicht Gold Mining Company, Ltd., to produce sulphuric acid, have indicated that such an installation would be warranted. An application has accordingly been submitted to the Atomic Energy Board for permission to enter this field. Loan funds to meet the capital cost of the project are estimated at £430,000.

### Mineral Discoveries in Northern Rhodesia

Two minerals of some strategic importance—germanium and lithium—have been discovered in Northern Rhodesia, according to an announcement by the Department of Commerce and Industry. Germanium has been identified by the Department of Geological Survey in the copper-bearing ores existing at the Sable Antelope Mine at Mimbwa. Two lithium-bearing ores have been discovered in the Choma district. It is stressed that much work remains to be done before it will be known whether either of these minerals is present in sufficient quantities to warrant exploiting.

### Aluminium Production Expansion

A big expansion programme is announced by the Aluminium Company of South Africa (Pty.), Ltd. (ACOSA). Within the next year the company will spend £250,000 on important extensions to its Pietermaritzburg factory. Most of the expenditure will be in connection with the installation, in a new building, of modern extrusion presses and other equipment for the production of extruded aluminium alloy sections and tubes. When this expansion is completed the total investment in the company will exceed £1,500,000. The new plant is expected to be in production during the second half of 1956.

### Uranium Mining in Northern Rhodesia

Ore from a small uranium-bearing ore body is to be mined and treated at the Rhokana Corporation mine at Kitwe, Northern Rhodesia. Metallurgical examination of this small uranium-bearing ore body in the Mindola section of the mine has been going on for the last two years. A satisfactory method for the treatment of the ore has been evolved, and arrangements are being made with the United Kingdom Atomic Energy Authority whereby the company will mine the uranium ore and treat it in a plant which will be erected for the purpose. The Authority has agreed to buy the resulting product on a " cost-plus " basis.

# Outlook for the American Shipbuilding Industry

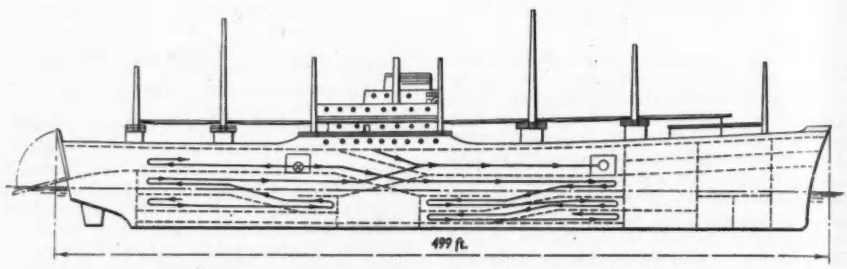
BY OUR AMERICAN EDITOR

IN recent months the gloom prevailing in American shipbuilding circles has been dispelled to a certain extent and 1954 ended on a more optimistic note than was expected earlier in the year. Substantial progress has been made by the U.S. Government in fostering a ship construction programme and the maintenance of shipbuilding and repairing facilities. Thus, the 1955 Navy programme has moved ahead with fifteen of thirty-five vessels scheduled being ordered from private shipyards. Five destroyers and four destroyer escorts have been contracted for on negotiated bids. Four destroyer escorts and two dock landing ships have been awarded for construction on the basis of competitive bids. Tenders on small craft have been received and negotiations started with the yards concerned. The Maritime Administration programme has met with considerable success. The emergency-repair programme has provided needed work for many ship repair firms. As at December 1st of last year, sixty-eight contracts totalling 1,227,581 dollars had been awarded for work on some thirty-five vessels. The scheduled conversion of "Liberty" ships has resulted in the placing of two contracts with shipyards, two design contracts with naval architects and three machinery orders. These two conversions involve one to diesel propulsion and the other to steam turbine propulsion. When the machinery designs are advanced far enough, shipyards will also be requested to bid on two contracts for conversion to gas turbine and free-piston engine propulsion.

There has been unexpected activity in the tanker "trade-in-and-build" programme. The Maritime Administration had always felt that this was a sound approach to the problem of upgrading the tanker fleet and placing additional tonnage in the American Reserve Fleet. However, the idea had to be sold to private industry, since it would increase capital expense. Three oil companies have so far realised that advantages can accrue to them by this programme and other firms are likely to follow suit in the near future. The Cities Service Oil Company has already signed a contract which will result in the construction of three tankers. The Esso Shipping Company and the Texas Company have indicated that they will follow this lead which will result in ordering three more vessels. The designs of the new passenger-cargo ships which are to be built for the Grace Line and the Moore-McCormack Line are very close to completion. A great deal of labour and development is necessary to prepare plans acceptable to the operating firms as well as to the American Government. Requests for bids are expected to go out for these vessels to the yards this month.

The negotiations with the American President Lines have reached a stage where it is expected that bids will be requested for the conversion of four "Mariner" class cargo vessels for this line within the next two months. A recent development has been the plan announced by the Oceanic Steamship Company to purchase and alter two "Mariner" class vessels at an estimated cost of 21,500,000 dollars. This programme may have to await action by Congress, however. The Maritime Administration has placed orders with the Sun Shipbuilding and Dry Dock Company and the Ingalls Shipbuilding Corporation for four "super-tankers." Acting as construction agent for the U.S. Navy, competitive bids were received and awards made by the Administration on a fixed price basis. Congress had appropriated 30,000,000 dollars for the construction of up to five tankers, but the appropriation was not large enough to cover this quantity. The four tankers now ordered will cost 27,661,573 dollars.

Congress has also appropriated 50,000,000 dollars for the construction of certain special-purpose ships for the Military Sea Transportation Service, including five ice-strengthened ships. Three of these vessels will be for general cargo. The design is being prepared by H. Newton Whittelsey, Incorporated, and should be ready for bidding in March. The other two are small tankers with the design being prepared by the New York Shipbuilding Corporation and should be ready for bidding in April. Another prototype ship is a cargo ship (dock) which is being designed by Gibbs and Cox, Incorporated. This ship will be somewhat similar to an "LSD" in size, speed and capacity, but will not have the military or repair facilities contained in ships of the fleet. Finally, a particularly interesting special-purpose ship now being designed for the U.S. Navy Bureau of Ships by George G. Sharp, Incorporated, is the so-called "roll-on, roll-off" vessel, which is shown diagrammatically in the accompanying illustration. Such ships have been considered by the American armed forces for some time in an effort to reduce cargo-handling costs and the turn-around time of cargo vessels. The handling costs of unloading cargo from wagons or lorries to the pier, re-handling and stowage aboard the ship and the same process at the point of destination represents a large percentage of the regular freight costs. A "roll-on, roll-off" vessel would not only save time in cargo handling but would also be the most expeditious manner of handling military vehicles. Brigadier-General F. S. Benson, jun., testified at a recent official hearing that 1,000,000 dollars a year would have been saved if such specially designed ships could have been available during the Korean emergency. After more than three years of study a feasible preliminary design was recently developed by the Bureau of Ships. In order to check the preliminary design, experiments were conducted by the Army Transportation Corps at Fort Eustis, Virginia. A mock-up of the ship's decks was laid out, full scale, on a concrete surface. The bulkheads, side ports, ramps, stanchions, &c., were painted on the surface of a large parking lot. Vehicles of various kinds and sizes were driven through this mock-up to check clearances, turning radius, capacity, time, and to test ways of loading and unloading. The Bureau of Ships then contracted with the naval architect to prepare the final design and specifications.




**Diagrammatic view of "roll-on, roll-off" vehicle carrying vessel**

The resultant ship fully meets American Bureau of Shipping classification and has the following principal characteristics :—

| | |
|---|---|
| Length overall | 499ft |
| Length between perpendiculars | 475ft |
| Beam, moulded | 78ft. |
| Depth | 48ft 9in. |
| Draught, loaded, vehicles | 22ft |
| Draught, loaded, cargo | 27ft |
| Displacement, light, tons | 10,000 |
| Displacement, loaded, vehicles, tons | 14,100 |
| Displacement, loaded, cargo, tons | 18,100 |
| Speed, normal, knots | 18 |
| Cruising range, miles | 13,000 |
| Crew | 22 |

In the outward profile the vessel appears much the same as a regular merchant vessel, but with more cargo-handling gear and a large freeboard compared to draught. The inboard profile is different. Decks are staggered, ramps lead up and down, the two vehicle holds have two hatches each and are extremely long, 130ft each, and the machinery casing is split—half on the port side and half on the starboard side. The main deck will have six hatches with quick-acting covers. Hatches on the lower decks will be flush with the decks. The two forward hatches will be small and will open into separate holds to be used for carrying package goods and general cargo. The other four hatches—two forward and two aft of the 'midship house—will serve the vehicle holds. These hatches will be 30ft wide and vary in length from 37ft 6in to 42ft 6in. In the forward vehicle hold vehicles can be stored on three decks and the tank top. In the after hold vehicles will be stored on three decks only.

Vehicles will be loaded from either side through the two large side ports on each side, through a stern port or by the cargo gear. In this manner the vessel is independent of dockside cranes or other floating equipment. All the ports open on the second deck. Leading from the second deck are ramps up to the main deck and down to the first platform. These two ramps will be situated amidships in a tunnel formed by the port and starboard halves of the machinery casings. One will be movable so that it can be used as a bridge between the forward and after holds. Such an arrangement is necessary when loading by the stern port. From the first platform to the second platform and the second to the tank top the ramps will be situated next to the shell. All the ramps will have a 14 deg. slope. All the hatches will have sufficient strength to support vehicles. On the main deck, where there are hatch coamings, vehicles will be lifted by the ship's gear from the deck to the covers for stowage. There will be 15,000 square feet of parking space on the main deck. The overhead clearances of the holds will be 12ft 6in on the second deck, 10ft 6in on the first platform, and 7ft on the second platform and tank top. Ramps leading from the dock to the side ports will not be built into the ship's structure. The stern ramp will form part of the transom and will operate similar to the bow ramp of a landing vessel.

The design of such a vessel presented many problems. In order to obtain sufficient longitudinal strength the sides amidship had to be extended above the main deck. The deck scantlings had to be increased since vehicles present concentrated loads where the wheels rest. In order to carry all kinds of vehicles in a sufficient number, it was necessary to have a large depth in relation to draught, thus affecting stability. All the large heavy vehicles will be stored on the second deck and main deck with the lighter vehicles in the lower holds. The floodable length was another consideration, with the final arrangement resulting in a two-compartment vessel. The machinery layout constitutes a radical change from previous standards. The boilers are situated next to the shell, port and starboard. The uptakes lead into individual casings on either side of the second deck tunnel. Each side has an individual funnel, which will appear as a large vent or kingpost on each side of the bridge house. There will be a structure that appears as a large funnel, but will be a dummy which houses special equipment with a conning station on top. The two turbines and related equipment driving twin screws will all be situated under the first platform amidship. Since the vessel may be travelling with a very light load or empty, large deep tanks will be provided forward and aft for ballasting. The ship is designed also as a general cargo vessel. In this class of service the assigned draught is 27ft,

while as a vehicle carrier the draught will be 22ft.

The hazards incumbent with the storing of so many vehicles, each with an individual petrol tank, have been studied carefully. The ventilating system of the vehicle holds will include both supply and exhaust blowers so that the air will be changed rapidly. This system also will take care of the exhaust fumes created when the vehicle engines are in operation. The ventilation system will be connected to the heating system so that the vehicle engines will be kept in good condition during a voyage in cold climates. To prevent condensation a de-humidifying system also will be installed. A gas detection system will be installed, which will alert the operating personnel to any dangers from petrol fumes. A large drainage system will handle the washing down of the decks to get rid of petrol, mud and grease. While the entire vessel will have a carbon dioxide fire extinguishing system, consideration is being given to the installation of other fire-fighting equipment. Accommodation for the ship's operating personnel will be on the main deck just aft of the machinery casings, port and starboard. On the next deck above will be the galley, messrooms, individual officers' and crew's lounges. The ship's officers will be quartered on the next deck.

## Executive Development Programme at M.I.T.

THE Massachusetts Institute of Technology, Cambridge, Massachusetts, has announced details relating to the Sloan Fellowships which will be awarded to " young executives " engaged in American industry to enable them to take part in the Executive Development Programme at M.I.T. during the 1955–56 academic year. The School of Industrial Management at M.I.T. feels that because the Executive Development Programme extends over a full year, it achieves a breadth of coverage and degree of penetration into fundamentals which are impossible in a shorter space of time. The experience of the men who have participated in this programme over the past twenty years has indicated that it has wrought a profound change of vision and effectiveness. The men—and their companies—have confirmed that this twelve-month experience has enhanced their ability to work effectively with people and has strengthened their sense of long-range affiliation with their own companies and with the objectives of a free-enterprise economy.

The fellowships will be awarded to thirty to thirty-five young executives, and these Sloan Fellows will be organised into two groups of fifteen to eighteen men each. Each Sloan Fellowship carries with it a financial award which helps to defray a portion of the costs of participating in the Executive Development Programme. Each candidate for a Sloan Fellowship must be nominated by his employer and have from him the promise of financial support for the year. Nominations are welcomed from both large and small companies, and from a variety of industrial and other business backgrounds. Companies should base their choice of men for nomination on a rigorous appraisal of the quality of the nominees' accomplishments to date and their ability and opportunity to grow into major business responsibilities. In the final selection of the fellows from among nominations, M.I.T. attempts to evaluate each nominee's potential for growth into major responsibilities ; there is no rigid requirement of a particular background. Thus, men from all sorts of enterprise and experience are invited, though the Institute continues to feel that engineering provides a very excellent background for management in to-day's technically complex economy.

The programme of study involved is designed especially to help fellows widen their horizons and deepen their understanding of the environment of industry. When the participants return to their companies, it is believed they will know more thoroughly how the demands of production, personnel, marketing and financial control all fit into a total operation. For the first few months of the programme, the fellows undertake a preliminary study of management and economic problems as their first exposure to the organised examination of these fields. During later months they study intensively such subjects as management operations (accounting control, marketing and production), finance, industrial relations and public policy, human relations, administrative policy, pertinent social sciences (foreign policy, law, industrial change and industrial history), and management theory. In addition, there will be a series of technical seminars at which members of the M.I.T. faculty in science and engineering discuss with the Sloan fellows new developments in these fields. Throughout the regular academic year, members of the Executive Development Programme meet each week for dinner and evening seminars with a business leader who is substantially senior to them and to their normal associations in industry. Three week-long field trips to the Middle West, to New York and to Washington are planned during the academic year. These trips make possible personal visits to managements of companies in many fields of activity and to government officials who are responsible for Federal policies affecting all phases of the American economy.

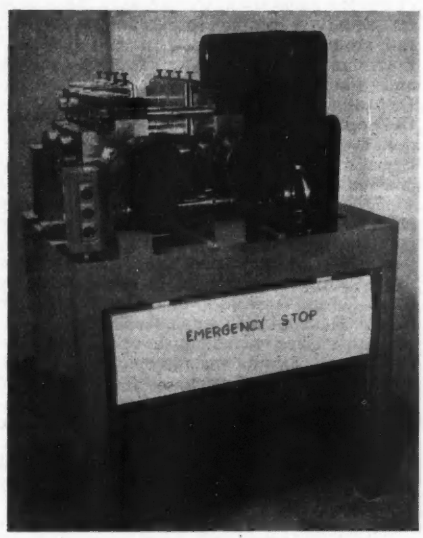
## Continuous Compacting of Metal Powder

IN the last few years there has been growing interest in the United States in methods of compacting metal powders on a continuous basis. One such method which is now finding commercial application is the roll bonding of metal powders into sheet, strip, rod and wire. The process was initiated on iron powder during the last war in Germany by the Mannesmann Company. It has been adapted to non-ferrous metal powders in America by the Chemetals Corporation, of New York, a research and development company which holds the rights to licence the process.

Roll bonding has been found to offer a solution to shaping and forming metals and alloys that are difficult to produce by ordinary ingot rolling practice. Materials which are produced in sponge or powder form also may be fabricated by this process. The materials are formed and shaped to specific sizes and thicknesses without preliminary working, and the product has properties similar to those of normally rolled materials of the same chemical composition. In roll bonding, powder of predetermined and selected properties is fed from a hopper to a set of horizontal rolls. The accompanying illustration shows a representative American horizontal two-high compacting mill, with 6in diameter by 6in face width rolls, which is made by the Stanat Manufacturing Company, of Long Island City, New York. The powder is compacted between the rolls and passes from them as a green, porous strip with sufficient strength to hold it together. The strip may be rolled on a reel or passed into an atmosphere furnace for sintering and consolidation. It is fragile but strong enough to run through the furnace on a belt or on rolls. When sintered for a brief period in the furnace at a temperature slightly below its melting point, the strip tends to shrink, densify and consolidate. As it emerges from the furnace, it is not like normal dense strip made by conventional processes ; instead it is a satiny, porous material. The strip must be further consolidated by multiple pass re-rolling and annealing until it attains full density and a structure comparable to strip made by other methods.

Wire rod is made in a similar manner. Sintered roll-bonded material is consolidated to over 90 per cent of the actual density, from which point it can be drawn through conventional dies into fine wire. In rod and bar made conventionally, particles of oxide on the surface tend to scale as the wire is drawn down to fine sizes. Powder rod does not possess this surface oxide. Hence, it is believed that much finer wire sizes will be possible when powder is used as a starting material. Among the major factors affecting the rolling and the properties of the strip are the particle shape and particle distribution of the powder ; the powder composition, the roll clearance ; the roll diameter ; the surface condition of the rolls; the speed of the rolls; the power of the motor; and the extent of the additional passes given to the sintered strip. The critical roll clearance is a function of the roll diameter. A ratio of 100 to 1 now appears to be the conventional relationship between roll diameter and maximum strip thickness. This ratio is related to an angle of nip or bite of about 7 deg. and is dependent upon the coefficient of friction between powder and rolls. Basically, the thicker the strip the larger the roll diameter must be. As the roll speed is increased, a critical point can be reached at which cohesive strip is no longer formed. However, with copper, for example, powder has been roll-bonded at a speed of 30 r.p.m., and the limiting speed has not been approached.

The rolling of metal powder may be considered as a continuous moulding process performed by narrow, linear segments along the rolls. It has been found that the sintering temperatures are extremely important. The increase in the strength of the compacted material and decrease in sintering time are dependent upon how closely the operator can approach melting without an appreciable distortion or softening of the strip with possible adhesion to the holding media. For example, copper is now sintered at 1830 deg. Fah., iron at 2190 deg. to 2550 deg. Fah., and brass at 1560 deg. Fah. The initial sintering times must be extremely brief to facilitate the use of reasonably short sintering furnaces for continuous operation. Tests have




**6in by 6in two-high horizontal powder compacting mill**

established that the degree of reduction should not exceed 10 to 20 per cent per pass, with an annealing step in between, so as to avoid transverse cracks. After the fourth or fifth pass, the powder strip can be handled in the same manner as conventional strip. Good tensile strength is produced after two or three passes ; several passes are required to achieve higher elongation values. Low annealing temperatures below the critical points are required in order to avoid excessive grain growth.

The following table shows certain physical properties of annealed copper strip made by the roll-bonding process.

| Strip thickness | Ultimate tensile strength | Elongation in 2in |
|---|---|---|
| 0·0106in | 40,100 lb per square inch | 34·0 per cent |
| 0·0061in | 39,800 lb per square inch | 25·5 per cent |

The electrical conductivity of the material at a temperature of 84 deg. Fah. was found to be 101 per cent.

## Award of 1954 Edison Medal

THE 1954 Edison Medal has been awarded by the American Institute of Electrical Engineers to Dr. Oliver T. Buckley, of Maplewood, New Jersey. He is a retired president of the Bell Telephone Laboratories, Incorporated. The medal was presented at the Institute's winter meeting on February 2nd, when Dr. Buckley, who has had a distinguished career in electrical engineering as a research physicist, inventor and executive, was cited for his personal contributions to the development of the transatlantic telephone cable and for outstanding service to the American Government.

### Quartermaster Corps Research and Development Centre

THE dedication took place recently of the Research and Development Centre of the Quartermaster Corps, U.S. Army, at Natick, Massachusetts. Situated on Lake Cochituate, 15 miles west of Boston, the centre consolidates all research activities of the Corps, except for the separate installations of the Food and Container Institute for the Armed Forces in Chicago, and the Field Evaluation Agency at Fort Lee, Virginia. The new centre has a particularly interesting Climatic Research Building, which houses chambers equipped to simulate weather conditions anywhere in the world. Temperatures from −70 deg. to 168 deg. Fah. are attainable, together with wind velocities up to 40 m.p.h. Precipitation as rain or snow can also be controlled. These chambers will enable simulated service testing of the many developmental items for which the Corps is responsible. An indication of the size of the two chambers, one for Arctic and one for tropic conditions, may be gained from the size of the fans used to generate the 40 m.p.h. wind. Each fan is 13ft in diameter and requires a 400 h.p. motor to drive it.

The Research Building, which is the largest of the ten buildings at the centre, is 500ft long, 60ft wide, and has three stories and a basement. In it are the research elements of four divisions : Environmental Protection ; Textile, Clothing and Footwear ; Pioneering Research, and Dispensing and Handling Equipment. The Development and Engineering Buildings are occupied by personnel of the Mechanical Engineering, the Textile, Clothing and Footwear, and the Chemicals and Plastics Divisions. The studies conducted by the Mechanical Engineering Division have been directed toward extending the use of light metals, especially in portable and personal equipment carried by the individual soldier. Among the facilities are metal-working shops for the fabrication of prototypes of such items. There are also ample facilities for metallurgical studies, including the preparation of metal specimens for microscopic examination. Also available are machines for determining such physical characteristics of metals as hardness, tensile and flexural strengths, and resistance to corrosion and deterioration from exposure to climatic extremes. Another interesting and useful project has been the development of X-ray equipment for the inspection of the quality of tinned foods.

Considerable space has been set aside in the engineering building for pilot plant investigations on plastics and rubber by the Chemicals and Plastics Division. Compounding and sample fabrication facilities include a rubber mill, a four-roll inverted calender, a coating machine and several hydraulic presses. Several years ago the Quartermaster Corps was directed to assume the responsibility for research in low-temperature rubber for the Department of the Army. As a result of this assignment, the Q.M.C. has developed, in co-operation with several outside laboratories, an elastomer having superior properties at low temperatures as compared with " GR–S " synthetic rubber or natural rubber. The favourable strength-weight ratio of reinforced plastic materials is being exploited by the use of these materials in such items as arctic sled boats, pack boards, bread boxes, food lockers, &c. Other current uses for plastics include tableware and buttons. Unsupported film and coated fabrics are being investigated for a number of possible applications. Film has possibilities for protective clothing and as a protective covering for equipment in addition to its obvious use in food packaging. Coated fabrics are being used for rainwear and, to a limited extent, in tentage. The Corps has for some years maintained extensive testing facilities for plastics and especially for films and coated fabrics. The test facilities for plastics and rubber include various conditioned rooms and machines for determining physical properties of plastics and rubber, and accelerated weathering equipment is also available. Other products coming under the Chemicals and Plastics Division are detergents, fungicides, rodenticides, germicides, pretreatments, protective finishes, paper and paper products, adhesives, and laminated plastics, such as those designed to afford bullet protection.

Two major activities in textiles which are centred in the engineering building are the Dyeing Laboratory and the Tentage and Equipage Branch. Additional space for the Textile, Clothing and Footwear Division is being prepared in the other buildings for work on textile engineering, functional finishes for textiles, leather technology, and design of textile items. Extensive testing facilities are available for determining the properties of textiles. These include both the more conventional machines for properties which have been well defined and standardised, and also some instruments for making measurements of a research nature, such as the elusive factors affecting human comfort.

### Most Beautiful Steel Bridges in the United States

THE accompanying illustrations show the three winners of the twenty-sixth Annual Aesthetic Bridge Competition conducted by the American Institute of Steel Construction. As in the previous year, the jury decided not to award the top prize in Class I, comprising bridges with spans in excess of 400ft. The winner in Class II, for bridges with spans under 400ft., costing over 500,000 dollars, was that shown in Fig. 3. The structure was designed by the Bridge Department, Division of Highways, State of California, and fabricated by the Bethlehem Pacific Coast Steel Corporation. It was acclaimed by the jury not only as a winner, but as " the most imaginative entry, because it is an honest structural solution to a difficult and complex problem." In the jury's opinion, " there is great harmony in the structure, even though both single and double columns are used in the supports. It exemplifies the strength, simplicity and integrity which can be accomplished merely by the use of steel alone."

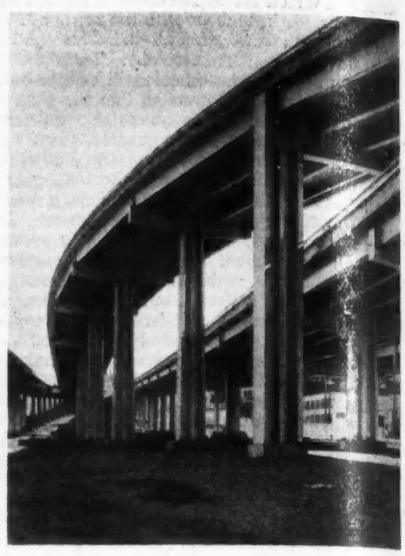


Fig. 3—Ninth and Tenth Street connections of Bayshore Freeway in San Francisco

In Class III, for bridges with fixed spans under 400ft and costing less than 500,000 dollars, the winner was the Robert Street pedestrian underpass over the South Freeway at Fort Worth, Texas. The structure was designed by the Texas Highway Department and fabricated by the North Texas Steel Company. This bridge was selected " because it has a fine, graceful profile and because as a pedestrian bridge it is designed in an intimate scale to fit into the community it serves."

In Class IV, for movable bridges, this year's prize was awarded for the bridge shown below. The structure was designed by Howard, Needles, Tammen and Bergendoff and fabricated by the Mount Vernon Bridge Company. It was selected " because of its unadorned structural integrity. It is simple and direct in design and offers an unusual solution."

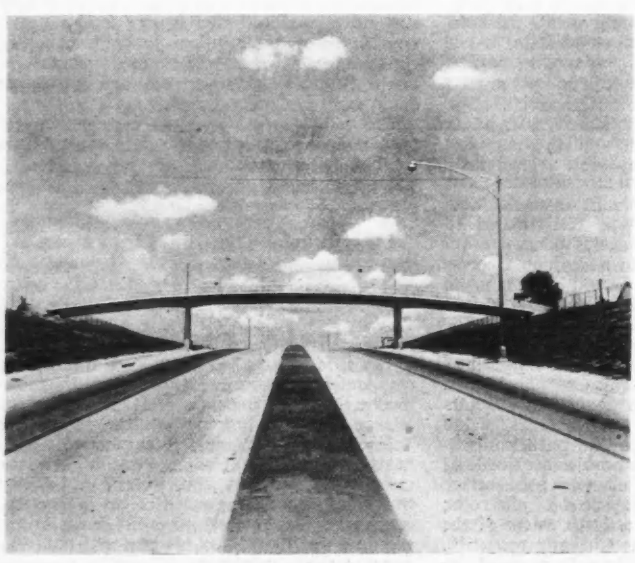


Fig. 1—Robert Street pedestrian underpass over South Freeway at Fort Worth, Texas

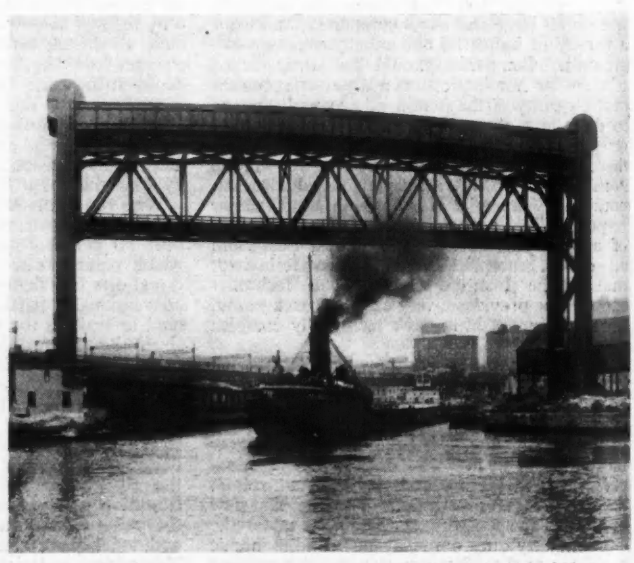


Fig. 2—New York Central Railroad bridge No. 8, over the Cuyahoga River at Cleveland, Ohio

# Industrial and Labour Notes

### British Productivity Council

The British Productivity Council has prepared an interim report on the working of its " circuit scheme " over the past eighteen months. It may be recalled that this scheme provides for the regular exchange of visits between six or eight neighbouring firms which agree to constitute a " circuit." The visits are made by small selected teams on which management, technicians and operatives are represented, the primary purpose being to promote the exchange of knowledge about machines, methods and ideas which have proved effective in raising productivity. An important ancillary purpose of the visits is to assist in creating a climate of opinion at all levels receptive towards any and all measures calculated to increase industrial efficiency. The Council says that in the past eighteen months or so about 7000 inter-factory visits have been made, the firms concerned constituting a cross section of industry, by size and product, in the areas where they operate. It is claimed that these visits have created an extensive body of practical experience from which to assess the value of the scheme and to guide participants on how best to put it into effect.

### Europe's Coal Industry

The Organisation for European Economic Co-operation has published a report, prepared by its coal committee, which surveys the coal situation in Western Europe during 1953 and 1954. The report analyses the various factors influencing the market, such as production, output, consumption, stocks, prices and trade, and, in its general conclusions, is fairly optimistic as to the short-term trend of the coal market in O.E.E.C. member countries.

About coal production in Western Europe, the report says that a figure of 476 million tons was reached last year, which means that, for the first time since 1945, the pre-war level was achieved. At the same time, it is pointed out that, despite all the efforts made in the various countries, productivity in the coal mining industry has remained below the 1938 level in Germany and the Netherlands ; in Belgium the 1938 productivity figure has been reached, and in France, the Saar and the United Kingdom it has been exceeded. The report also includes figures showing the increase in coal consumption in O.E.E.C. countries since 1950. It is stated that after a particularly heavy demand in 1951, as a result of events in Korea, there was a slight decline in 1952 and 1953. That decline, however, was partially made good last year, when Europe's coal consumption was 6,000,000 tons higher than in 1953.

In its report, the committee has endeavoured to determine the extent to which coal consumption during the last two years has been affected by structural factors or by the general economic situation. In this matter, it is pointed out that hydro-electric power, natural gas and fuel oil are all competing with coal, though to a different degree in the various member-countries of the O.E.E.C.

### Alloy Steel Prices

The Iron and Steel Board has announced increases in the maximum prices of alloy steels containing nickel, molybdenum or tungsten, on account of the higher cost of those materials. The steel price increases vary according to the alloy content. Examples mentioned in the Board's announcement are alloy black bars, the new prices for which are £54 15s. 3d. a ton to Specification E.N.10, and £88 16s. 3d. a ton to Specification E.N.27.

The prices of some stainless steels and some of the alloy qualities of shell steel and forging ingots have been increased for the same reason. The Board has also increased the maximum prices of cold rolled strip, of 6in wide and narrower, by £1 a ton, and has reduced the maximum prices of free cutting quality and acid quality bright steel bars by amounts ranging from 6s. 6d. to 2s. 6d. a ton. These changes, which operated from February 7th, have no significant effect on the level of steel prices as a whole.

### Underground Railway Wage Dispute

At the end of last week it was stated that there had been no satisfactory conclusion to the discussions between the London Transport Executive and the railway unions about the wage claims for London's underground railway workers. Most of the workers concerned, including the majority of the motormen, are members of the National Union of Railwaymen. The N.U.R. is pressing for a basic weekly rate of £9 18s. for motormen, which is the maximum weekly rate for main line engine drivers on British Railways.

The rates offered for all grades of underground railway workers, with the exception of the motormen, are at least as high, London Transport says, and in many cases higher than the rates recently accepted by the N.U.R. for comparable grades on British Railways, the increases ranging from 7s. 6d. to 12s. 6d. a week. The London Transport Executive has proposed that the matter should be referred to the London Transport Railway Wages Board for determination in accordance with the agreement which the N.U.R. executive undertook to honour in January. Neither side is bound to accept the findings of this Wages Board, but London Transport has, in this instance, given an undertaking in advance that it will accept the Board's decisions. London Transport has also offered that all the wage increases which it has proposed should be paid forthwith pending the result of the reference to the Wages Board. The N.U.R., however, decided at the beginning of the week to seek an interview with Sir Brian Robertson, chairman of the British Transport Commission, for discussion of the matter.

In a statement about motormen's wages, the London Transport Executive says it is not satisfied that the rate of £9 18s. a week agreed between British Railways and the N.U.R. for steam locomotive drivers is necessarily the proper rate for motormen on the London Transport system, in view of the conditions of operation and the large number of mechanical and electrical aids, including safety devices, that have been introduced over the years on London Transport's railway system in order to simplify the motorman's task. At present the motorman's maximum standard rate is £9 2s. a week, the average standard wage for a rostered forty-eight-hour week of six days, including work on alternate Sundays, amounts to £10 19s. 11d. a week. London Transport has now offered a maximum standard rate of £9 12s. a week, which would mean an average standard wage of £11 12s. a week. The London Transport Executive holds the view that this offer could be said to go beyond the appropriate rate which should be paid for the job having regard to all the circumstances. If there is to be any further increase in the rate, London Transport says that it must be as a result of an independent examination and evaluation of the proper rate for the job. Such an evaluation, it claims, can properly be made by the Wages Board.

### Employment and Unemployment

The Ministry of Labour reports that at the end of December the number of people in civil employment in Great Britain was 22,714,000 (15,060,000 men and 7,654,000 women). This was 104,000 less than at the end of last November, most of the decrease being accounted for by the fact that there were fewer women in civil employment. During the whole of last year, however, the number of people in civil employment in this country increased by 350,000, the biggest increase, amounting to 260,000, being in the manufacturing industries.

An analysis of civil employment at the end of last year shows that there were 9,171,000 people at work in the manufacturing industries. Of the total, there were 2,712,000 employed in the engineering, metal goods and precision instruments group, compared with 2,598,000 at the end of December, 1953. In vehicle manufacture, there were 1,210,000 people at work at the end of 1954, compared with 1,157,000 a year earlier. In the basic industries at the end of last year, 3,955,000 people were employed, the principal changes during December being seasonal decreases in transport and agriculture. There was a small addition to colliery manpower during December, the total at the end of the month being 705,000. In other industries and services there was a decrease of 11,000 during December in the number of people employed in building and contracting, the total being 1,438,000. That figure was 19,000 higher than a year earlier.

A report on unemployment states that on January 10th there were 297,847 people registered as out of work, compared with 256,308 registered on December 6th. The Ministry of Labour says that the number of unemployed registered on January 10th included 17,000 described as temporarily stopped and was 75,000 below the number registered in January, 1954. The number of people who, on January 10th, had been out of work for more than eight weeks was 110,000, which represented 39 per cent of the wholly unemployed.

### Coal Supplies

In a written Parliamentary answer, the Parliamentary Secretary to the Ministry of Fuel and Power, Mr. Joynson-Hicks, stated last Monday that in the first four weeks of this year coal output had again been below expectations. Coal imports in that period, however, had amounted to 607,000 tons, compared with 72,000 tons in the corresponding weeks of last year. Stocks amounted to 14,300,000 tons on January 29th, compared with 17,500,000 tons a year earlier, but, Mr. Joynson-Hicks added, it was expected that between now and the end of April coal imports would show an increase of more than 2,000,000 tons compared with last year.

Coal consumption in the first three weeks of this year was 14,400,000 tons, or about 527,000 tons more than in the corresponding weeks of last year. The latest figures published by the Ministry of Fuel and Power show that, last week, production from the deep mines amounted to 4,384,100 tons, and from opencast workings 156,200 tons, making a total of 4,540,300 tons. In the comparable week of 1954, the total saleable coal output was 4,571,000 tons.

### Higher Fees for Patents and Designs

The Board of Trade states that, as from February 1st, higher renewal fees are charged for patents and designs registrations due to expire after April 30, 1955. After that date, there will be a general increase in fees payable in respect of a number of patents and designs matters. It is explained that these fees have remained substantially unchanged for many years despite considerable increases in administrative costs. The Board of Trade has laid before Parliament revised rules which amend those made under the Patents Act, 1949, and the Registered Designs Act, 1949. In addition to providing for higher fees, the Patents Rules have also been amended in minor respects to make them conform to the requirements of the European Convention of December 11, 1953, relating to the formalities required for patent applications.

### Iron and Steel Production

The Iron and Steel Board reports that the production of steel ingots and castings averaged 380,600 tons a week in January and was therefore at an annual rate of 19,789,000 tons, compared with an annual rate of 18,737,000 tons in January, 1954. The highest monthly output of steel previously recorded was in November last, when production averaged 377,300 tons a week. Pig iron output in January averaged 236,400 tons a week, which represented an annual production rate of 12,292,000 tons, compared with 11,941,000 tons in January last year.

# Personal and Business

## Appointments

MR. RICHARD L. HEARN has been elected chairman of the Canadian Hydro-Electric Power Commission.

MR. DOUGLAS C. NEILLANDS has been appointed assistant secretary to the North of Scotland Hydro-Electric Board.

MR. C. WATTS has been appointed sales manager (foundry) of Distington Engineering Company, Ltd., Workington, Cumberland.

MR. DAVID BETT has been appointed public relations officer of the Hunting Group of Companies, 4, Dunraven Street, London, W.1.

MR. L. F. SOUTHORN has been appointed manager of the Sheffield office of C. A. Parsons and Co., Ltd., in succession to Mr. A. N. G. Wood, who has retired.

THE STANTON IRONWORKS COMPANY, Ltd., near Nottingham, states that Mr. G. R. Buckley, the general works manager, has been appointed a director.

THE PRESIDENT OF THE BOARD OF TRADE has appointed Mr. R. W. Burkitt to be deputy comptroller-general of the Export Credits Guarantee Department.

PAMETRADA announces that its senior research engineeer, Mr. B. J. Terrell, has been appointed senior designer in succession to the late Mr. H. G. Yates.

MR. H. G. CONWAY, M.I.Mech.E., F.R.Ae.S., has been appointed a director of Short Bros. and Harland, Ltd., Belfast. He has been the company's chief engineer since April last.

BABCOCK AND WILCOX, Ltd., states that Mr. H. H. Smith, assistant manager of the special vessels department, has been appointed sales manager of Edwin Danks and Co. (Oldbury), Ltd.

THE EFFINGHAM STEEL WORKS, Ltd., Sheffield, states that Mr. Oscar W. Mortimer, representative in the West Riding, Lancashire, and North Midlands, has been appointed a local director of the company.

HIGH DUTY ALLOYS, Ltd., Slough, announces the appointment of Mr. C. J. Williams as manager of the casting division. He succeeds Mr. J. A. Wellings, who has been appointed director and vice-president of Canadian Steel Improvement, Ltd., Toronto.

MR. S. J. PRESTON, A.M.I.E.E., of Electric and Musical Industries, Ltd., has been elected chairman of the Radio Communication and Electronic Engineering Association. Mr. C. H. T. Johnson, of Decca Radar, Ltd., has been elected vice-chairman.

NORTHERN ALUMINIUM COMPANY, Ltd., states that Mr. B. N. H. Thornely has been appointed secretary of the company in addition to his duties as a director. Mr. E. A. Trigg has been appointed chief financial officer, and Mr. J. Mason has been appointed chief accountant.

SIR EWART SMITH, M.I.Mech.E., has been appointed a deputy chairman of Imperial Chemical Industries, Ltd. He joined Synthetic Ammonia and Nitrates, Ltd. (subsequently I.C.I. Billingham Division) in 1923, and has been technical director of Imperial Chemical Industries, Ltd., since 1945.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby, states that Mr. H. B. Mellor has been transferred from the lighting department of the Birmingham office to the power and apparatus side of the company's business. He will operate chiefly in the Potteries area. Mr. R. G. Mills has been appointed a power engineer at the B.T.H. Sheffield office, and Mr. J. Nicholson has been appointed power sales engineer at the Manchester office.

## Business Announcements

MR. R. C. FARNHAM, managing director of Fuel Firing, Ltd., Woodley, Reading, is on a tour of South Africa.

ALFRED HERBERT, Ltd., Coventry, is now the sole distributor throughout the world of the products of George Richards and Co., Ltd., Broadheath, Near Manchester.

FORGE CRAFT (WOOD GREEN), Ltd., states that it has now moved its works to a new factory at Brownfields, Welwyn Garden City, Herts (telephone, Welwyn 3356).

FIRMA WILHELM RUMP, Gertrudenstrasse 11, Hamburg, 1, has taken up the shipyard representation of Associated British Oil Engines (Export), Ltd., and National Oil Engines (Export), Ltd.

BRAITHWAITE, COURT AND CO., Ltd., 23, Commercial Road, Woking, states that it has extended its technical illustration and draughting services to include fine machine engraving. Mr. A. Evans has joined the company as sales director.

THE AGENT GENERAL FOR BRITISH COLUMBIA has been notified by the Vancouver Board of Trade that a buying mission consisting of forty-eight business and industrial leaders from Vancouver will be visiting the United Kingdom between April 12th and 23rd.

ALUMINIUM UNION, Ltd., states that it has opened branch sales offices at Gazette Buildings, Corporation Street, Birmingham (telephone, Central 1446), and at National House, 36, St. Ann Street, Manchester (telephone, Blackfriars 9772). Mr. W. J. Cadd is in charge of the Birmingham office and Mr. A. W. K. Lees of the Manchester office.

SCHIESS A.G., Dusseldorf, Germany, announces that in the future the sole selling agents in Great Britain for all its machines, with the exception of gear hobbers, will be Burton Griffiths and Co., Ltd. Sales of the firm's gear hobbers will be handled by Alfred Herbert, Ltd. Servicing of the machines in this country will be carried out by the respective agents.

## Contracts

THE HEAD WRIGHTSON MACHINE COMPANY, Ltd., Middlesbrough, has received from Richard Thomas and Baldwins, Ltd., for installation at the Ebbw Vale works, an order valued at about £600,000 to cover the supply of a continuous strip galvanising line. This line, which will operate the Armco Sendzimir process under licence from the Armco Steel Corporation, has a potential annual capacity of 60,000 tons of galvanised sheet. The line, which will be almost 700ft long, is designed to receive coils of steel strip up to 48in wide and 30,000 lb in weight, and to produce up to 10 tons per hour of galvanised sheet. The installation is expected to go into production early in 1957.

THE GENERAL ELECTRIC COMPANY, Ltd., has received an order, valued at nearly £1,000,000, from the Johannesburg Municipality to supply for the Kelvin power station three 30MW turbo-alternator sets, complete with feed heating and evaporating plant, bringing the total number of sets on order or under construction for this station to six. The steam conditions will be 600 lb per square inch gauge at the turbine stop valve and a temperature of 850 deg. Fah. The turbines are of two-casing design with twenty-two stages of high pressure and six stages, double-flow, of low pressure. The 37·5MVA alternators are air cooled, generate at 11kV and have direct-coupled exciters. Each set is provided with a four-stage feed heating plant giving a final feed temperature of 356 deg. Fah. at full load, designed and manufactured by Vickers-Armstrongs, Ltd. The consultants to the municipality are Messrs. Merz and McLellan.

## Miscellanea

CONCRETE FACING SLABS.—A booklet illustrating and describing the uses of concrete facing slabs has been published by the Cement and Concrete Association, 52, Grosvenor Gardens, London, S.W.1. from whom copies may be obtained free of charge.

GAS TURBINES AT ASHFORD COMMON FILTRATION WORKS.—In our issue of January 14th we mentioned details of the three 2500kW gas turbine generators which are being delivered to the Metropolitan Water Board. On page 56 one of these sets, that made by Metropolitan-Vickers Electrical Company, Ltd., was inadvertently referred to as being of 1500kW capacity.

NATIONAL SAVINGS IN INDUSTRY.—The National Savings Committee has stated that at the end of last September 1,171,634 workers in places of employment in England and Wales with over 500 people, apart from the nationalised industries, were saving regularly through 2142 savings groups. Their total group savings for the six months ended September 30th were £15,413,734.

ALUMINIUM ALLOY SECTIONS.—The Aluminium Development Association, 33, Grosvenor Street, London, W.1, has published an addendum to Information Bulletin No. 18, entitled "Aluminium Alloy Sections for Marine Use." This gives in tabular form the relevant data of three series of new sections, namely, bulb angles for riveting, bulb plates for welding and tee bars for welding.

IMPROVED EFFICIENCIES OF "OSRAM" COLOUR-MATCHING TUBES.—Improvements have been announced in the average light output of G.E.C. "Osram" colour-matching fluorescent tubes (5ft and 4ft) during the first 5000 hours of their life. In the 5ft 80W tube the new output is 2640 lumens, an increase of 18 per cent; in the 4ft 40W tube the output is increased by 20 per cent to 1440 lumens.

MULTI-DUTY LABORATORY MILL.—A machine which is suitable for a variety of purposes such as grinding, mixing, shaking and polishing, in laboratories has been introduced by Podmores (Engineers), Ltd., Pyenest Street, Shelton, Stoke-on-Trent. This machine consists essentially of a double-ended, pedestal-mounted shaft, driven by a motor enclosed in the base of the pedestal. The drive is transmitted through a worm reduction gear and three speed unit. A number of different fittings are designed for mounting on the flanges at the ends of the shaft. These attachments include the wet grinding pot and a double cone dry mixing pot. Wet or dry grinding pot mills, with capacities from ¼ to 3 gallons are available in porcelain, stainless steel or rubber-lined steel. For polishing, scouring or deburring purposes an octagonal barrel with a total capacity of 0·65 cubic foot can be fitted. A churning or shaking fitting for flasks taking up to 2 Winchester quarts is available, and different kinds of churns or bottle holders can be supplied to suit different requirements.

DISTRIBUTION OF CONCENTRATED LOADS BY LAMINATED TIMBER SLABS.—The distribution of load in, and the load bearing capacity of, laminated timber slabs is investigated in a recent bulletin (No. 424) of the Engineering Experiment Station of the University of Illinois, which has the above title. The most important factor in the distribution of concentrated load among the laminations of a slab, it is stated, is the type and arrangement of fasteners; the most satisfactory spacing of nails is stated.

DEMONSTRATION OF MACHINE TOOLS IN BIRMINGHAM.—The Rockwell Machine Tool Company, Ltd., is holding a demonstration of machine tools at its Birmingham showrooms from March 22nd to April 1st. The demonstration will largely be devoted to Jung internal grinding machines. Five different models of these machines will include a fully automatic and a semi-automatic machine; a machine with a high-speed spindle running at 80,000 r.p.m.; and a machine for grinding internal forms. In addition to these machines, Thiel tool room machines and many other tool room and production machines will be demonstrated.

GLASS FIBRE LAMINATES.—A new range of glass fibre/polyester resin laminates is being made for the engineering, electrical and aircraft industries by Rubber Improvement, Ltd., Wellingborough, Northants. These materials are available in various grades but are generally characterised by their high mechanical strength and heat resistance combined with insulation properties. Some grades of the laminates are fire retardent and are suitable for use in the aircraft industry and a general property grade available is generally used in the form of blanks in electrical components. This general grade has good punching and machining properties.

WIRE MESH FAN GUARD.—A new fan guard has been developed by Keith Blackman, Ltd., Mill Mead Road, London, N.17, to comply with the statutory requirements associated with Section 14 of the Factories Acts, 1937. This guard is stated to impart the necessary degree of safety and yet not to offer appreciable restrictions to air flow or create additional air noise. The guard consists of wire mesh so arranged that the section immediately adjacent to the fan ring is formed cylindrically and it is built up of much closer wire mesh. Special fixing plates are incorporated with the fan ring so that the new guard can be fitted with the firm's "A.P.A." fans.

INDUSTRIAL PAINT FINISHING COSTS.—In November last a conference on the measurement and control of industrial paint finishing costs was convened by the Paints Division of I.C.I. and held in London. In the course of this conference the three main papers presented were:—"The Measurement of Industrial Paint Finishing Costs," by Mr. H. H. Morcross; "The Control of Industrial Paint Finishing Costs," by Mr. D. C. Sandilands; and "The Foreman's Part in Cost Control," by Mr. W. J. Izzard. These papers and the discussions at the conference have now been published in book form by Imperial Chemical Industries, Ltd., Millbank, London, S.W.1.

POLYTHENE TUBING COUPLINGS.—As a result of the development in the use of polythene tubing for cold water services, a range of couplings, adaptors, stop taps and ferrules for under-pressure service connections has now been introduced by E. Pass and Co., Ltd., of Denton, Manchester. Two joints are made by the firm—the "Lancaster" for heavy-gauge tube, and the "S.P." for normal gauge. Both are compression joints, the "Lancaster" having a screwed sleeve on to the pipe, and the "S.P." joint a polythene tube support sleeve which is integral with the ferrule or adaptor. This sleeve has serrations into which the polythene is compressed under the action of a nut and compression ring.

SAFETY CODE FOR INDUSTRIAL POWER TRUCKS.—The Industrial Truck Manufacturers' Association has just issued a booklet entitled "Safety Code for Industrial Power Trucks." This booklet opens with a section on construction and design considerations covering the basic requirements for driver-operated and pedestrian-controlled trucks of various kinds. It then deals in detail with the method of computing and notifying safe working loads; operation of equipment; nomenclature and operators' safety rules and regulations. The book is being circulated to a selected cross-section of industry and is available to interested concerns at 2s. 6d. net from the association's offices, 94/98, Petty France, London, S.W.1.

NAVAL CONSTRUCTION IN 1954.—Our attention has been drawn to certain errors in the article under this title published in our issue of January 7th. H.M. "Daring" class ship "Diana" is not propelled by turbines of Parsons type as stated. The turbines in both the "Decoy" and "Diana" are of an advanced English Electric Company's design. Double-reduction gearing for the "Decoy" was designed and cut by the Fairfield Shipbuilding and Engineering Company, Ltd.; that for the "Diana" was designed and built by the Maag Gear-Wheel Company of Zurich. In relation to frigates it is worth adding that the size of the twin-screw "Whitby" class and twelve of the single-screw "Blackwood" class are all propelled by English Electric steam turbines of 15,000 h.p. per shaft.

# British Patent Specifications

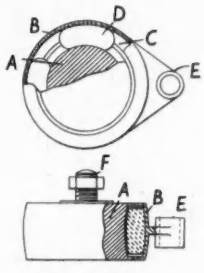
*When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.*

*Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.*

## ROAD TRANSPORT

**721,636.** September 19, 1952.—Shock Absorbers for Vehicles, Giulio Virgilio Scanzi, Rue Tartaglia 47, Brescia, Italy.

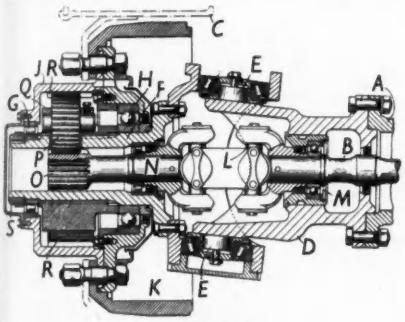
The invention relates to shock absorbers in which relative rotary movement between two parts of the absorber produce temporary deformation of elastic means interposed between the parts with consequent damping action. As the drawing shows, the shock absorber comprises two coaxial and relatively turnable casing members, an inner disc *A* and an outer ring *B*, with an annular space *C* between them. Elastic or rubber blocks *D* are mounted under pressure in the annular space, the blocks assuming substantially a kidney shape, as shown by the drawing, and bearing on the walls of the members *A* and *B*. The ring *B* has a lug terminating in a bush *E*, while the disc *A* has a projecting threaded pin *F* for the attachment of the device to a vehicle in the ordinary way. The forces to be damped are imparted through suitable linkage to the lug or flange *E*. In operation, as relative movement occurs between the two casing members temporary deformation of the blocks *D* is produced, producing a smooth damping action free from sudden, undesirable snatching.—*January* 12, 1955.



No. 721,636

**721,784.** July 18, 1952.—Axles for Motor Road Vehicles, Kirkstall Forge Engineering, Ltd., and Frederick Raymond Cowell, both of Kirkstall Forge, Leeds, 5, Yorkshire.

The invention relates to steering and driving axles for motor road vehicles. As the drawing clearly shows, the axle includes a main axle casing comprising a central basin to receive the differential gear and outwardly projecting arms *A*, each of which is bored to receive a driving shaft *B* for the drive from the differential gear to one of the road wheels *C*. To the end of each arm of the axle casing is fixed a hollow member *D*, formed with trunnions *E* carrying roller bearings constituting pivots for a swivel axle *F*, the arrangement being that the swivel axle can pivot relatively to the axle casing so as to permit steering of the wheel. The swivel axle constitutes an outward continuation of the arm *A* of the axle casing and carries a pair of spaced bearings *G* and *H*, on which the wheel hub *J* can turn. The wheel is secured to the hub and to the brake drum *K* by nut and bolt connections as shown. The driving shaft *B* includes a universal joint constituted by a pair of Hookes couplings *L* placed close together with their axes at equal distances on opposite sides of the axis of the bearing about which the swivel axle *E* turns relatively to the member *D*. The portion of the driving shaft extending in from the inner coupling is supported in a ball bearing *M*, which holds it against axial sliding movement, while the portion *N* of the driving shaft on the outside of the outer coupling is supported in a bearing which permits it to slide to some extent relatively to the swivel axle. The wheel hub *J* is driven from the portion *N* of the driving shaft by a hub reduction gear between the two bearings. The gear comprises a wheel *O* formed by gear teeth in the outer end of the driving shaft, a pinion *P*, carried on a fixed carrier *Q* keyed to the swivel axle *F*, and an internally toothed crown *R* on the wheel hub *J*. Three pinions are provided, one only being shown in the drawing. A nut *S*, fitted to the end of the swivel axle, holds the carrier and hub bearings in position on the swivel axle. The gear wheel *O* on the driving shaft is capable of endwise movement with respect to the pinions *P* so that the drive can be maintained notwithstanding movement of the swivel axle *F* relatively to the supporting member *D*. The steering and driving axle, according to the invention, is primarily intended for use on a vehicle having a front wheel drive. It will be appreciated, however, that it is not essential that this axle should be the front one, and also that a number of steering and driving axles, according to the invention, may be fitted to one and the same vehicle.—*January* 12, 1955.

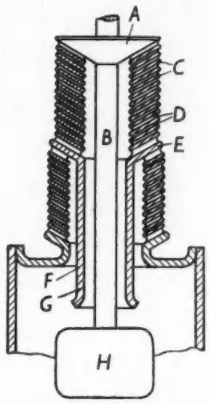


No. 721,784

## ELECTRICAL ENGINEERING

**716,376.** March 29, 1951.—Vapour Electric Arc Converters, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2; and William George Thompson, of The General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

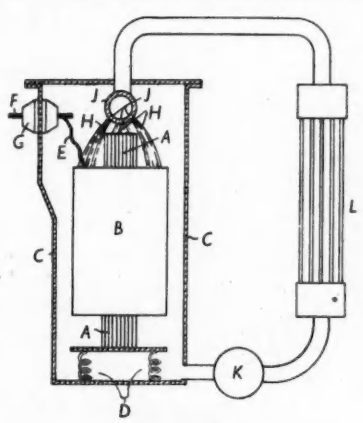
The invention relates to vapour electric arc converters and to the seal arrangements for such converters. As will be seen from the drawing, the vitreous seal is supported by the cylindrical wall of the side arm. the bottom ring of the seal being welded to the side arm wall. The top of the seal is sealed with vitric material to a conical flange *A* on the anode supporting stem *B*, which extends axially through the seal, and supports a graphite anode *H* in the upper part of the side arm. The seal is formed as shown, with upper and lower cylindrical parts composed of a number of superposed coaxial metallic rings *C*, spaced by vitric material *D*. The axial lengths of the two parts of the seal are approximately equal, the inner and outer diameters of the ring *C* being slightly smaller than those of the lower part. At the point on the seal where the two parts join one of the metallic rings *E* is formed on the flared end of a metallic sleeve *F* which is coaxial with and surrounds the anode supporting stem *B*, and ends in a flared shroud *G* over the top of the anode *H*. The metal sleeve *F* forms a voltage dividing screen between the anode supporting stem *B* and the lower part of the seal. The sleeve has the effect of reducing the electrical stress in the low-pressure space between the stem and the seal, thereby enabling the arrangement to work at relatively high voltages.—*October* 6, 1954.



No. 716, 376

**718,129.** February 7, 1952.—Electric Transformers, Metropolitan-Vickers Electrical Company, Ltd., St. Paul's Corner, 1–3, St. Paul's Churchyard, London, E.C.4. (*Inventor: Arthur Samuel Ennis.*)

The invention relates to electric transformers and reactors, and is concerned with the reduction of noise emanating from them. Referring to the drawing, a transformer having a core and windings indicated at *A* and *B* respectively is resiliently mounted in a tank *C* on spring supports *D*; connection of the windings *B* of the transformer with external equipment is made by way of flexible leads such as *E* and conductors such as *F* passing through the tank wall in insulating bushings *G*. For cooling the transformer an electrically insulating liquid, indicated at *H*, is sprayed over the cores and windings from perforations formed in a pipe *J* which extends horizontally within the tank above the transformer. The sprayed liquid collecting at the bottom of the tank is recirculated by means of a pump *K*, which pumps the liquid through a cooler *L* back to the pipe *J*. With such an arrangement vibrations originating in the transformer core and transmitted to the tank walls will be considerably attenuated by virtue of the spring mountings of the transformer and the flexibility of the leads to the windings. Moreover, the air filling the space between the transformer and the tank walls will have a cushioning effect which will also help to attenuate vibrations passing to the tank walls.—*November* 10, 1954.

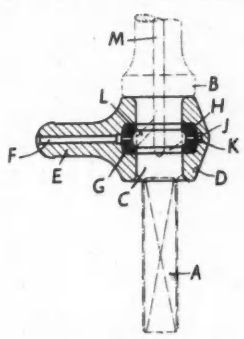


No. 718,129

## MINING ENGINEERING

**721,600.** October 29, 1951.—Flushing Heads for Rock Drills, Friedrich Heinrich Flottmann, Kortumstrasse 146, Bochum, Germany.

The object of the invention is to provide a flushing head of as short a length as is reasonable and which, at the same time, is such as to permit the pipe connection to be made integral with the casing of the flushing head. A construction according to the invention is shown in the drawing. The insert end *A* of the drill, which has a collar *B*, has a cylindrical part *C* on which the flushing head *D* is mounted. The casing of this flushing head is integral with an adjoining pipe connection *E* which extends radially and has a bore *F* for the inflow of flushing medium. The casing of the flushing head has an annular groove *G* fitted with a sealing ring *H*. This ring is solid, except for a shallow annular groove, and the radial passages *J*. Concentric with the annular groove and located in the casing is a further annular groove *K*. In use, the flushing medium passes through the channel *F* into groove *K* and thence through the radial passages *J* into the annular groove in the sealing ring. From here it flows through an inclined passageway *L* in the drill stem *C* into a flushing channel *M* extending axially through the drill. The sealing ring *H* is so dimensioned that, when the insert end *A* is pushed into position it is compressed to seal on the cylindrical part *C*. The sealing pressure is increased by the flushing medium in the vicinity of the annular groove *K*. The invention permits an advantageous shortening of the cylindrical stem of the insert end of the drill, which lightens the drill weight and reduces danger of breakage.—*January* 12, 1955.



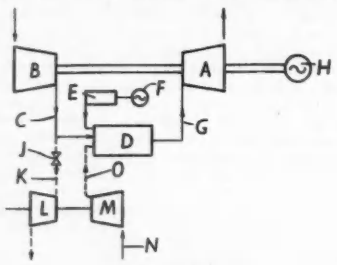
No. 721,600

## GAS TURBINES

**722,230.** September 5, 1952.—Gas Turbine Plant, The Metropolitan-Vickers Electrical Company, Ltd., St. Paul's Corner, 1–3, St. Paul's Churchyard, London, E.C.4. (*Inventors: James Forrest Shannon and Harold Farrington.*)

The invention relates to open-cycle gas turbine plant, simple or compounded, capable of being readily adapted at will to run on any one of a variety of fuels having different calorific values, without serious loss in efficiency. The drawing shows a gas turbine plant designed for utilising liquid fuel of high calorific value or gaseous fuel of low calorific value. A turbine *A*, designed to run on liquid fuel of relatively high calorific value, is mechanically coupled to a compressor *B*. Air from the compressor is conveyed through a duct *C* to a combustion chamber *D*, into which liquid fuel is injected by a pump *E* driven by an electric motor *F*. The gaseous combustion products are then conducted through a duct *G* to the turbine. The turbine is coupled to an electric generator *H*. When it is desired to run the plant on fuel having a lower calorific value it is necessary to reduce the mass flow of air supplied to the combustion chamber *D* by an amount equivalent to the additional mass flow of fuel. For

this purpose a controllable by-pass valve *J* is provided in a duct *K* connected with the duct *C*. By opening the by-pass valve some of the pressure air can be diverted to operate suitable means for converting its energy into useful work, such as, for example, an air turbine *L*, which can be used to drive




No. 722,230

a power take-off shaft. In the case of plant designed to utilise gaseous fuel of low calorific value it is convenient to couple the air turbine *L* to a compressor *M*, to which the gaseous fuel is supplied through a duct *N*. The fuel after leaving the compressor passes through a duct *O* to the combustion chamber *D*. Although the embodiment described above relates to the utilisation of only two different fuels, it may be modified to permit the selective burning of more than two different fuels.—*January* 19, 1955.

## Launches and Trial Trips

OWERRI, cargo liner ; built at the Belfast shipyard of Harland and Wolff, Ltd., for Elder Dempster Lines, Ltd.; length overall 450ft, length between perpendiculars 425ft, breadth moulded 62ft, depth moulded to shelter deck 34ft, gross tonnage 6240 ; two complete steel decks, eight watertight compartments, four main cargo holds and deep tanks, seventeen derricks with lifts ranging from 3 tons to 12 tons, one 30-ton and one 50-ton derrick ; electric deck machinery ; four 125kW diesel-driven generators, one vertical composite boiler ; Harland and Wolff two-stroke, single-acting, opposed piston diesel engine, five cylinders 620mm diameter by 1870mm combined stroke, 115 r.p.m. Trial, January 21st.

DEMODOEUS, cargo and passenger ship ; built at the Walker yard of Vickers-Armstrongs, Ltd., for Alfred Holt and Co.; length overall 487ft, breadth moulded 62ft, depth moulded 35ft 3in, deadweight 9000 tons, draught loaded 28ft ; six main holds ; Harland and Wolff pressure-charged opposed-piston diesel engine, six cylinders, 8000/8800 b.h.p. Launch, January 24th.

CRETIC, cargo liner ; built at the Wallsend yard of Swan, Hunter and Wigham Richardson, Ltd., for Shaw, Savill and Albion Company, Ltd.; length between perpendiculars 481ft, breadth moulded 69ft, depth moulded to upper deck 33ft 4½in, load draught 30ft 3in, deadweight 10,750 tons, service speed 17 knots ; six holds ; four insulated derricks to lift 5, 7 and 12 tons, also one to lift 25 tons and one to lift 70 tons ; two 480kW, two 200kW and one 75kW diesel-driven generators ; two Wallsend-Doxford single-acting, two-stroke oil engines each having six cylinders 670mm, diameter by 2320mm, total power 12,860 b.h.p. at 114 r.p.m. Launch, January 25th.

PATHFINDER, pilot vessel ; built by Philip and Son, Ltd., for the Pilotage Department of Trinity House ; length overall 175ft, length between perpendiculars 157ft, breadth moulded 30ft, depth moulded 14ft, draught mean 10ft 3in, speed 11½ knots ; accommodation for twenty-two pilots, electric deck machinery, two 60kW diesel-driven generators ; two British Polar two-cycle, single-acting mark M.46.1 diesel engines, each of 500 b.h.p. at 325 r.p.m. Trial, January 25th.

## Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### BRITISH INSTITUTION OF RADIO ENGINEERS

*Wed., Feb. 23rd.*—S. WALES SECTION : Glamorgan Technical College, Treforest, "The Training of Radio Engineers," H. W. French, 6.30 p.m.

### CHEMICAL SOCIETY

*To-day, Feb. 11th.*—NEWCASTLE AND DURHAM BRANCH : Chemistry Building, King's College, Newcastle upon Tyne, "The Place of Theoretical Chemistry in Chemical Education," R. P. Bell, 5.30 p.m.——ST. ANDREWS AND DUNDEE BRANCH : Chemistry Department, The University, St. Andrews, "The Organic Chemistry of Phosphorus," H. N. Rydon, 5.15 p.m.

### DIESEL ENGINE USERS ASSOCIATION

*Thurs., Feb. 17th.*—Caxton Hall, Westminster, London, S.W.1, "Prevention of Scale and Corrosion in the Water-Cooling Systems of Internal Combustion Engines," E. L. Streatfield, 2.30 p.m.

### ILLUMINATING ENGINEERING SOCIETY

*Mon., Feb. 14th.*—SHEFFIELD CENTRE : The University, Western Bank, Sheffield, "Some Aspects of Industrial Lighting from a Factory Inspector's Viewpoint," D. E. Jones, 6.30 p.m.

*Tues., Feb. 15th.*—LIVERPOOL CENTRE : Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool, "Design and Application of Flameproof Lighting Equipment," D. A. Strachan, 6.30 p.m.

*Wed., Feb. 16th.*—N. LANCASHIRE GROUP : N.W. Electricity Board, 19, Friargate, Preston, "Lighting for Sport," A. Wilcock, 7.15 p.m.——TEES-SIDE GROUP : Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "The Design and Application of Flameproof Lighting Equipment," D. A. Strachan, 6.30 p.m.

### INCORPORATED PLANT ENGINEERS

*To-day, Feb. 11th.*—BIRMINGHAM BRANCH : Imperial Hotel, Birmingham, Annual Dinner.

*Tues., Feb. 15th.*—S. WALES BRANCH : Mackworth Hotel, Swansea, "Refrigeration as Affecting Industry," D. E. Hall, 7.15 p.m.

*Wed., Feb. 16th.*—GLASGOW BRANCH : Scottish Building Centre, 425–427, Sauchiehall Street, Glasgow, "Some Factors Concerning Works Capital Expenditure," F. Franklin, 7 p.m.——KENT BRANCH : Bull Hotel, Rochester, "Industrial Gas Turbines," J. R. Needham, 7 p.m.——WESTERN BRANCH : Grand Hotel, Bristol, "The Protection of Structural Steel Against Corrosion," K. H. Gibbons, 7.15 p.m.

*Thurs., Feb. 17th.*—BLACKBURN BRANCH : Golden Lion Hotel, Blackburn, "Statutory Requirements in Connection with Boilers and Other Pressure Vessels," G. A. Anderson, 7.30 p.m.——MERSEYSIDE AND N. WALES BRANCH : Royal Institution, Colquitt Street, Liverpool, "Electronic Control," G. Horsfall, 7.15 p.m.

### INSTITUTE OF BRITISH FOUNDRYMEN

*Sat., Feb. 12th.*—NEWCASTLE BRANCH : Neville Hall, Westgate Road, Newcastle upon Tyne, "Production of Heavy Steel Castings," S. Taylor, 6 p.m.——SCOTTISH BRANCH : Royal Technical College, Glasgow, "Some Aspects on Steel Foundry Practice," H. Hart, 3 p.m.

*Sat., Feb. 19th.*—E. MIDLANDS BRANCH : College of Arts, Derby, "Factors Governing Graphite Formation in Cast Iron," P. A. Russell, 6 p.m.

### INSTITUTE OF FUEL

*To-day, Feb. 11th.*—EAST MIDLAND SECTION : The "Black Boy," Nottingham, Annual Dinner, 7 p.m.

*Mon., Feb. 14th.*—NORTH-EASTERN SECTION : Chemistry Lecture Theatre, King's College, Newcastle upon Tyne, Students' Evening, 6.30 p.m.

*Wed., Feb. 16th.*—YORKSHIRE SECTION : Hotel Metropole, Leeds, "An Approach to Fuel Economy in a Large Engineering Works," F. A. Worsley, 2.30 p.m.——N.W. SECTION : Grosvenor Hotel, Chester, "Relations between the Petroleum Industry and the Government," V. Butler, 7.30 p.m.

### INSTITUTE OF MARINE ENGINEERS

*Mon., Feb. 14th.*—STUDENT LECTURE : 85, Minories, London, E.C.3, "Boilers," A. P. Monk, 6.30 p.m.

*Wed., Feb. 16th.*—JUNIOR LECTURE : Technical College, Birkenhead, "Marine Closed Feed Systems," D. C. Hagen, 7 p.m.

### INSTITUTE OF METALS

*Mon., Feb. 14th.*—SCOTTISH LOCAL SECTION : Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, "Some New Developments in Nickel Alloys," A. B. Graham and C. C. Horne, 6.30 p.m.

*Wed., Feb. 16th.*—Birmingham University, Edgbaston, Birmingham, Informal Discussion on "Non-Metallic Die Materials," 10.30 a.m.

### INSTITUTE OF PETROLEUM

*Mon., Feb. 21st.*—26, Portland Place, London, W.1, "The Modern Planning of Regional Surveys for Petroleum," P. Leicester, 5.30 p.m.

### INSTITUTE OF ROAD TRANSPORT ENGINEERS

*Wed., Feb. 16th.*—N.W. CENTRE : Adelphi Hotel, Liverpool, "The Production of Diesel Engines," General Discussion conducted by H. L. Parrish, 7.30 p.m.

*Thurs., Feb. 17th.*—LONDON CENTRE : Royal Society of Arts, John Adam Street, London, W.C.2, "Some Trends in Vehicle C.I. and Petrol Engine Lubrication," F. Lawrence, 6.30 p.m.——YORKSHIRE CENTRE : Hotel Metropole, King Street, Leeds, "Metal Spraying and Reclamation," Lloyd Manuel, 7.30 p.m.

### INSTITUTE OF WELDING

*Tues., Feb. 15th.*—E. MIDLANDS BRANCH : Victoria Station Hotel, Nottingham, "Cracking in Welded Steel Joints," K. Winterton, 7.15 p.m.——LIVERPOOL BRANCH : College of Technology, Byrom Street, Liverpool, "Welding for the Chemical Industry," T. Williams, 7.15 p.m.

*Wed., Feb. 16th.*—MANCHESTER BRANCH : College of Technology, Manchester, "Argonarc and Argonaut Welding," W. Woollcott, 7.15 p.m.——W. OF SCOTLAND BRANCH : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Modern Practice in the Welding of Pipes, Background and Present Trends," E. Fuchs, 7 p.m.

*Thurs., Feb. 17th.*—LEEDS BRANCH : Great Northern Hotel, Leeds, "Structural Steel Design," R. J. Fowler, 7.30 p.m.

### INSTITUTION OF CHEMICAL ENGINEERS

*Fri., Feb. 18th.*—N.W. BRANCH : College of Technology, Manchester, "A New Technique for Particle Size Distribution Analysis by Centrifugal Sedimentation," J. K. Donoghue and W. Bostock, 7 p.m.

### INSTITUTION OF CIVIL ENGINEERS

*Mon., Feb. 14th.*—NORTH-WESTERN ASSOCIATION : Reynolds Hall, College of Technology, Manchester, "The Process Building at Capenhurst : Some Structural Problems," T. C. Waters, 6.30 p.m.

*Tues., Feb. 15th.*—ORDINARY MEETING : Great George Street, Westminster, London, S.W.1, "Investigations into the Designs of Pressure Tunnels in London Clay," F. Tattersall, T. R. M. Wakeling and W. H. Ward, 5.30 p.m.

*Wed., Feb. 16th.*—MIDLANDS ASSOCIATION : Herbert Schofield Buildings, The College, Loughborough, "The Flood on the Lincolnshire Coast, and Remedial Measures," J. Finn, 7 p.m.

### INSTITUTION OF ELECTRICAL ENGINEERS

*Mon., Feb. 14th.*—EDUCATION DISCUSSION CIRCLE : Savoy Place, London, W.C.2, Discussion on "Teaching Faraday's Law of Electro-Magnetic Induction," opened by P. Hammond, 6 p.m.

*Tues., Feb. 15th.*—MEASUREMENTS SECTION : Savoy Place, London, W.C.2, "The Service Engineer at an Atomic Energy Establishment," W. E. Harris, 5.30 p.m.——N. SCOTLAND SUB-CENTRE : Burnetts Tearooms, 42, Academy Street, Inverness, "Natural Sources of Energy," J. E. Whittaker, 7.30 p.m.——S.E. SCOTLAND SUB-CENTRE : Carlton Hotel, North Bridge, Edinburgh, "High-Voltage Cables," J. S. Hastie, 7 p.m.

*Thurs., Feb. 17th.*—UTILIZATION SECTION : Savoy Place, London, W.C.2, "An Introduction to the Study of Servo-Mechanisms," P. J. Bhatt ; "The Development of 50 c/s Traction in France," E. J. Davies ; "Electricity Applied to Oil Production," G. Gascoigne, 5.30 p.m.

### INSTITUTION OF ENGINEERS-IN-CHARGE

*Wed., Feb. 16th.*—E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, "The Effect of Light on Plant Growth," J. F. Roper, 6.30 p.m.

### INSTITUTION OF MECHANICAL ENGINEERS

*To-day, Feb. 11th.*—GENERAL MEETING : 1, Birdcage Walk, Westminster, London, S.W.1, "The Effects of Velocity and Temperature of Discharge on the Shape of Smoke Plumes from a Funnel or Chimney," L. W. Bryant and C. F. Cowdrey, 5.30 p.m.

*Mon., Feb. 14th.*—LUTON A.D. CENTRE : Assembly Room, Town Hall, Luton, "Analysis and Interpretation of Service Records," A. T. Wilford, 7.30 p.m.

*Tues., Feb. 15th.*—GENERAL MEETING : 1, Birdcage Walk, Westminster, London, S.W.1, "Report on Investigation into the Failure of Two 100MW Turbo-Generators," Sir Claude Gibb, 5.30 p.m.——COVENTRY GRADUATES' A.D. SECTION : Craven Arms Hotel, High Street, Coventry, Films, "Miracle of Rubber," "Liberia : Africa's Only Republic," and "Fabulous 500," 7.30 p.m.——N.W. GRADUATES' SECTION : Engineers' Club, Albert Square, Manchester, Discussion on Plant Maintenance," opened by S. F. Timmins and A. B. Collier, 6.45 p.m.——YORKSHIRE GRADUATES' SECTION : The University, Leeds, "Planetary Gearing in Heavy Vehicle Axles," J. A. Tee, 7.30 p.m.

*Wed., Feb. 16th.*—N.E., A.D., CENTRE : The University, Leeds, "Engine Research and Development as a Service to Industry : A Personal Experience," J. H. Pitchford, 7.15 p.m.——SCOTTISH GRADUATES' SECTION : Y.M.C.A., 4, Queen Street, Edinburgh, "The Mechanical Engineer and the Reconstruction of an Existing Colliery," P. R. Venters, 7.40 p.m.——WESTERN GRADUATES' SECTION : Grand Hotel, Bristol, "The Development of Spill Atomizers for Gas Turbine Fuel Systems," W. H. Sleigh, 7.15 p.m.

*Thurs., Feb. 17th.*—MIDLAND BRANCH : James Watt Memorial Institute, Great Charles Street, Birmingham, "Recent Studies of Metallic Friction," F. P. Bowden, 6 p.m.——N.W. BRANCH AND N.W., A.D., CENTRE : Engineers' Club, Albert Square, Manchester, "An Experimental Investigation into the Effect of Fuel Addition to Intake Air on the Performance of a Compression Ignition Engine," W. T. Lyn ; "The Effect of Auxiliary Fuels on the Smoke-Limited Power Output of Diesel Engines," (the late) L. D. Derry, E. M. Dodds, E. B. Evans and D. Royle, 6.45 p.m.——SOUTHERN BRANCH : Technical College, Brighton, "Some Wider Aspects of Management," Sir Ewart Smith, 6.30 p.m.——WESTERN BRANCH : Frott's Restaurant, Milsom Street, Bath, "The Impact of Development and Research on Production and Design," L. H. Leedham, 7 p.m.——E. MIDLANDS GRADUATES' SECTION : Technical College, Eastfield Road, Peterborough, "Infinitely Variable-speed Gears," P. W. Johnson, 7.15 p.m.——MIDLAND GRADUATES' SECTION : James Watt Memorial Institute, Great Charles Street, Edinburgh, "Some Aspects of Aircraft Gas Turbines," E. J. Collins, 6.30 p.m.

*Fri., Feb. 18th.*—GENERAL MEETING : 1, Birdcage Walk, Westminster, London, S.W.1, "Pulsating Flow Measurement by Viscous Meters with Particular Reference to the Air Supply of Internal Combustion Engines," K. L. Kastner and T. J. Williams, 5.30 p.m.——SCOTTISH GRADUATES' SECTION : Royal Technical College, Glasgow, "Experimental Research at Glengarnock on Ship's Structural Members," K. V. Taylor, 7.30 p.m.

### INSTITUTION OF PRODUCTION ENGINEERS

*Mon., Feb. 14th.*—DERBY SECTION : College of Art, Green Lane, Derby, "Packaging," E. H. Dickens, 7 p.m.——SHEFFIELD SECTION : Grand Hotel, Sheffield, "The Manufacture of Engineers' Cutting Tools," C. A. Grayson, 6.30 p.m.——YORKSHIRE SECTION : Hotel Metropole, Leeds, "Work Study," L. G. Humble, 7 p.m.

*Wed., Feb. 16th.*—BIRMINGHAM SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "The Skilled Man in Industry," J. T. Boias, 7 p.m.——LIVERPOOL SECTION : Exchange Hotel, Liverpool, "Packaging," A. Frazer Much, 7 p.m.——NORWICH SECTION : Great Yarmouth Technical College, Gordon Road, Great Yarmouth, "Compressed Air as an Aid to Production," W. J. Ford, 7.30 p.m.——SOUTHERN SECTION : Polygon Hotel, Southampton, "Resistance Welding—Its Early History and Modern Development," H. G. Taylor, 7.15 p.m.——S. ESSEX SECTION : Mid-Essex Technical College, Chelmsford, "The Control of Size in Engineering Production," J. Loxham, 7.30 p.m.——WESTERN SECTION : The College, Swindon, "Mechanical Aids to Production," J. Eric Steel, 7.30 p.m.

*Thurs., Feb. 17th.*—GLASGOW SECTION : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Productivity and the Machine Tool," N. Stubbs, 7.30 p.m.

*Fri., Feb. 18th.*—STOKE-ON-TRENT SECTION : Town Hall, Hanley, Stoke-on-Trent, "From Diamond to Spark Machining," G. Fefer, 7.45 p.m.

### INSTITUTION OF THE RUBBER INDUSTRY

*Mon., Feb. 14th.*—MIDLAND BRANCH : James Watt Memorial Institute, Great Charles Street, Birmingham, "Racing Tyre Design," D. C. Hartley and D. M. Turner, 6.45 p.m.——S. WALES AND MONMOUTHSHIRE BRANCH : College of Technology, Cardiff, "Recent Developments in Processing," T. H. Messenger, 7.30 p.m.

### INSTITUTION OF WATER ENGINEERS

*Wed., Feb. 16th.*—S.E. SECTION : Institution of Civil Engineers, Great George Street, London, S.W.1, Films, "Leyton Marsh Culvert," preceded by a talk by S. R. Broderick, "How the Gas Turbine Works," followed by a talk on "The Gas Turbine and its Application to Water Supply," H. R. Lupton, 2.30 p.m.

### JUNIOR INSTITUTION OF ENGINEERS

*To-day, Feb. 11th.*—Pepys House, 14, Rochester Row, London, S.W.1, "Underground Water," K. G. Bewham, 7 p.m.

*Mon., Feb. 14th.*—SHEFFIELD AND DISTRICT SECTION : Livesey Clegg House, Sheffield, "Blast-Furnace Plant and Operational Problems," E. A. Cotterill ; "Electrical Equipment and Services for the Blast-Furnace Plant at the Park Gate Iron and Steel Works," H. Demaine, 7.30 p.m.

*Fri., Feb. 18th.*—INFORMAL MEETING : Pepys House, 14, Rochester Row, London, S.W.1, "The Atom," S. A. McAuliffe, 7 p.m.

### MANCHESTER ASSOCIATION OF ENGINEERS

*Fri., Feb. 18th.*—Engineers' Club, Albert Square, Manchester, "Some Aspects of Drop Forging Practice," K. Fidler, 6.45 p.m.

### MANCHESTER GEOLOGICAL AND MINING SOCIETY

*Thurs., Feb. 17th.*—Wigan and District Mining and Technical College, Wigan, "Methane Recovery and Utilisation at Old Boston Colliery," J. Coxon and Dr. Crawford, 3.15 p.m.

### OLD CENTRALIANS

*Mon., Feb. 14th.*—Chez Auguste Restaurant, 47, Frith Street, London, W.1, "One-Man Submarines," J. R. V. Dolphin, 12.45 p.m.

### REINFORCED CONCRETE ASSOCIATION

*Wed., Feb. 16th.*—11, Upper Belgrave Street, London, S.W.1, "Specifications for Concrete," D. A. Stewart, 6 p.m.

### ROYAL AERONAUTICAL SOCIETY

*Tues., Feb. 15th.*—GRADUATES' AND STUDENTS' SECTION : 4, Hamilton Place, London, W.1, "Is Postgraduate Study Abroad Worthwhile ?" Discussion, 7.30 p.m.

*Thurs., Feb. 17th.*—SECTION LECTURE : 4, Hamilton Place, London, W.1, "Problems Associated with Stress Concentrations," H. L. Cox, 7 p.m.

### ROYAL SOCIETY OF ARTS

*Wed., Feb. 16th.*—John Adam Street, Adelphi, London, W.C.2, "Welfare in a Large Family Firm," Hon. H. A. Cozens-Hardy, 2.30 p.m.

### SOCIETY OF CHEMICAL INDUSTRY

*Thurs., Feb. 17th.*—ROAD AND BUILDING MATERIALS GROUP : Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "A Study on the Significance of the Bitumen Ductility Test," R. N. J. Saal, 6 p.m.

### WOMEN'S ENGINEERING SOCIETY

*Wed., Feb. 16th.*—MANCHESTER BRANCH : Visit to Manchester Central Laundry Service, 6.45 p.m.